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NOVUM ORGANUM

OR

True Suggestions for the Interpretation of Nature

BY

FRANCIS LORD VERULAM

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PREFACE

THEY who have presumed to dogmatize on Nature, as on some well investigated subject, either from self-conceit or arrogance, and in the professorial style, have inflicted the greatest injury on Philosophy and Learning. For they have tended to stifle and interrupt Inquiry exactly in proportion as they have prevailed in bringing others to their opinion: and their own activity has not counterbalanced the mischief they have occasioned by corrupting and destroying that of others. They again who have entered upon a contrary course, and asserted that nothing whatever can be known, whether they have fallen into this opinion from their hatred of the ancient Sophists, or from the hesitation of their minds, or from an exuberance of learning, have certainly adduced reasons for it which are by no means contemptible. They have not, however, derived their opinion from true sources, and hurried on by their zeal, and some affectation, have certainly exceeded due moderation. But the more ancient Greeks (whose writings have perished) held a more prudent mean, between the arrogance of dogmatism, and the despair of Scepticism; and though too frequently intermingling complaints and indignation at the difficulty of inquiry, and the obscurity of things, and champing, as it were, the bit, have still persisted in pressing their point, and pursuing their *intercourse* with Nature: thinking, as it *seems, that the better* method was not to dispute upon the very point of the possibility of any thing being known, but to put it to the test of Experience. Yet they themselves, by only employing the power of the Understanding, have not adopted a fixed Rule, but have laid their whole stress upon intense Meditation, and a continual exercise and perpetual agitation of the Mind.

Our Method, though difficult in its operation, is easily explained. It consists in determining the degrees of Certainty, whilst we, as it were, restore the Senses to their former rank, but generally reject that operation of the Mind which follows close upon the Senses, and open and establish a new and certain course for the Mind from the first actual perceptions of the Senses themselves. This no doubt was the view taken by those who have assigned so much to Logic; showing clearly thereby that they sought some support for the Mind, and suspected its natural and spontaneous mode of action. But this is now employed too late as a remedy, when all is clearly lost, and after the Mind, by the daily habit and intercourse of life, has become prepossessed with corrupted doctrines, and filled with the vainest Idols. The art of Logic therefore being (as we have mentioned) too late a precaution, and in no way remedying the matter, has tended more to confirm Errors, than to disclose Truth. Our only remaining hope and salvation is to begin the whole labour of the Mind again; not leaving it to itself, but directing it perpetually from the very first, and attaining our end as it were by mechanical aid. If Men, for instance, had attempted mechanical labours with their hands alone, and without the power and aid of instruments, as they have not hesitated to carry on the labours of their Understanding with the unaided efforts of their Mind, they would have been able to move and overcome but little, though they had exerted their utmost and united powers. And just to pause awhile on this comparison, and look into it as a mirror; *let us ask, if any* obelisk of a remarkable size were perchance required to be moved, for the purpose of gracing a triumph or any similar pageant, and Men were to attempt it with their bare hands, would not any sober spectator avow it to be an act of the greatest madness? And if they should increase the number of workmen, and imagine that they could thus succeed, would he not think so still more? But if they chose to make a selection, and to remove the weak, and only employ the strong and vigorous, thinking by this means, at any rate, to achieve their object, would he not say that they were more fondly deranged? Nay, if not content with this, they were to determine on consulting the athletic art, and were to give orders for all to appear with their hands, arms, and muscles regularly oiled and prepared, would he not exclaim that they were taking pains to rave by method and design? Yet men are hurried on with the same senseless energy and useless combination in intellectual matters, as long as they expect great results either from the number and agreement, or the excellence and acuteness of their wits; or even strengthen their Minds with Logic, which may be considered as an athletic preparation, but yet do not desist (if we rightly consider the matter) from applying their own Understandings merely with all this zeal and effort. Whilst nothing is more clear, than that in every great Work executed by the hand of man without machines or implements, it is impossible for the strength of individuals to be increased, or for that of the multitude to combine.

Having premised so much, we lay down two points on which we would admonish mankind, lest they should fail to see or to observe them. The first of these is: that it is our good fortune (as we consider it), for the sake of extinguishing and removing contradiction and irritation of Mind, to leave the honour and reverence due to the Ancients untouched and undiminished, so that we can perform our intended work, *and yet* enjoy the benefit of our respectful *moderation. For if* we should profess to offer somethi better than the Ancients, and yet should pursue the same course as they have done, we could never, by any artifice, contrive to avoid the imputation of having engaged in a contest or rivalry as to our respective wits, excellences, or talents ; which though neither inadmissible or new (for why should we not blame and point out any thing that is imperfectly discovered or laid down by them, of our own right, a right common to all), yet however just and allowable, would perhaps be scarcely an equal match, on account of the disproportion of our strength. But since our present plan leads up to open an entirely different course to the Understanding, and one unattempted and unknown to them, the case is altered. There is an end to party zeal, and we only take upon ourselves the character of a guide, which requires a moderate share of authority and good fortune, rather than talents and excellence. This first admonition relates to Persons, the next to Things.

We make no attempt to disturb the system of Philosophy that now prevails, or any other which may or will exist, either more correct or more complete. For we deny not that the received system of Philosophy, and others of a similar nature, encourage discussion, embellish harangues, are employed and are of service in the duties of the professor, and the affairs of civil life. Nay, we openly express and declare that the Philosophy we offer will not be very useful in such respects. It is not obvious, nor to be understood in a cursory view, nor does it flatter the Mind in its preconceived notions, nor will it descend to the level of the generality of mankind unless by its advantages and effects.

Let there exist then (and may it be of advantage to both) two Sources, and two Distributions of Learning, and in like manner two Tribes, and as it were kindred families of contemplators or philosophers, without any hostility or alienation between them ; but rather allied and united by mutual assistance. Let there be in short one method of Cultivating the Sciences, and another of Discovering them. And as for those who prefer and more readily receive the former, on account of their haste or from motives arising from their ordinary life, or because they are unable from weakness of mind to comprehend and embrace the other (which must necessarily be the case with by far the greater number), let us wish that they may prosper as they desire in their undertaking, and attain what they pursue. But if any individual desire and is anxious not merely to adhere to and make use of present Discoveries, but to penetrate still further, and not to overcome his adversaries in disputes but nature by labour, not in short to give elegant and specious opinions, but to *know* to a Certainty and Demonstration, let him, as a true son of Science (if such be his wish), join with us; that when he has left the antechambers of Nature trodden by the multitude, an entrance may at last be discovered to her inner apartments. And in order to be better understood, and to render our meaning more familiar by assigning determinate names, we have accustomed ourselves to call the one method the *Anticipation of the Mind*, and the other the *Interpretation of Nature.*

We have still one request left. We have at least reflected and taken pains in order to render our propositions not only true, but of easy and familiar access to Men's Minds, however wonderfully prepossessed and limited. Yet it is but just that we should obtain this favour from Mankind (especially in so great a Restoration of Learning and the Sciences), that whosoever may be desirous of forming any determination upon an opinion of this our Work either from his own perceptions, or the crowd of authorities, or the forms of demonstrations, he will not expect to be able to do so in a cursory manner, and whilst attending to other matters; but in order to have a thorough knowledge of the subject, will himself by degrees attempt the Course which we describe and maintain ; will be accustomed to the subtilty of things which is manifested by experience ; and will correct the depraved and deeply rooted habits of his mind by a seasonable and as it were just hesitation : and then finally (if he will) use his judgment when he has begun to be master of himself.

NOVUM ORGANUM

OR, TRUE SUGGESTIONS FOR THE INTERPRETATION OF NATURE

BOOK I

APHORISMS

On the Interpretation of Nature and the Empire of Man

i. MAN, as the minister and Interpreter of Nature, does and understands as much as his observations on the Order of Nature, either with regard to things or the mind, permit him, and neither knows nor is capable of more.

ii. The unassisted hand, and the Understanding left to itself, possess but little power. Effects are produced by the means of Instruments and helps, which the understanding requires no less than the hand. And as instruments either promote or regulate the motion of the hand, so those that are applied to the Mind prompt or protect the Understanding.

iii. Knowledge and human Power are synonymous, since the ignorance of the cause frustrates the effect. For Nature is only subdued by submission, and that which in Contemplative Philosophy corresponds with the cause, in Practical Science becomes the *Rule.*

iv. Man, whilst *operating*, can only apply or withdraw *natural bodies; Nature*, internally, performs the rest.

v. Those who become practically versed in Nature, are the Mechanic, the Mathematician, the Physician, the Alchymist, and the Magician, but all (as matters now stand) with faint efforts and meagre success.

vi. It would be madness, and inconsistency, to suppose that things, which have never yet been performed, can be performed without employing some hitherto untried means.

vii. The Creations of the Mind and Hand appear very numerous if we judge by books and Manufactures: but all that variety consists of an excessive refinement, and of deductions from a few well known matters; not of a number of Axioms.

viii. Even the Effects already discovered are due to Chance and Experiment rather than to the Sciences. For our present Sciences are nothing more than peculiar Arrangements of matters already discovered, and not methods for discovery or plans for new Operations.

ix. The sole Cause and root of almost every defect in the Sciences is this; that whilst we falsely admire and extol the powers of the human Mind, we do not search for its real helps.

x. The subtilty of Nature is far beyond that of Sense or of the Understanding: so that the specious meditations, speculations, and Theories of mankind are but a kind of insanity, only there is no one to stand by and observe it.

xi. As the present Sciences are useless for the discovery of Effects, so the present system of Logic is useless for the discovery of the Sciences.

xii. The present system of Logic rather assists in confirming and rendering inveterate the errors founded on vulgar notions, than in searching after truth; and is therefore more hurtful than useful.

xiii. The Syllogism is not applied to the Principles of the Sciences, and is of no avail in intermediate Axioms, as being very unequal to the subtilty of Nature. It forces Assent, *therefore, and not things.*

xiv. The Syllogism consists of Propositions, propositions of words, words are the signs of Notions. If therefore the notions (which form the basis of the whole) be confused and carelessly abstracted from things, there is no solidity in the superstructure. Our only hope, then, is in genuine *Induction*.

xv. We have no sound Notions either in Logic or Physics; *Substance*, *Quality*, *Action*, *Passion*, and *Existence* are not clear notions; much less, *Weight*, *Levity*, *Density*, *Tenuity*, *Moisture*, *Dryness*, *Generation*, *Corruption*, *Attraction*, *Repulsion*, *Element*, *Matter*, *Form*, and the like. They are all fantastical and ill-defined.

xvi. The notions of less abstract Natures, as *Man*, *Dog*, *Dove*; and the immediate perceptions of sense, as *Heat*, *Cold*, *White*, *Black*, do not deceive us materially, yet even these are sometimes confused by the mutability of Matter and the Intermixture of things. All the rest, which men have hitherto employed, are errors; and improperly abstracted, and deduced, from things.

xvii. There is the same degree of licentiousness and error in forming Axioms, as in abstracting Notions: and that in the first principles, which depend on common induction. Still more is this the case in Axioms and inferior propositions derived from Syllogisms.

xviii. The present discoveries in Science are such as lie immediately beneath the surface of common notions. It is necessary, however, to penetrate the more secret and remote parts of Nature, in order to abstract both Notions and Axioms from things, by a more certain and guarded Method.

xix. There are and can exist but two ways of investigating and discovering truth. The one hurries on rapidly from the senses and particulars to the most general Axioms; and from them as principles and their supposed indisputable truth *derives and discovers* the intermediate Axioms. This is the way now in use. The other constructs its Axioms from the senses and particulars, by ascending continually and gradually, till it finally arrives at the most general axioms, which is the true but unattempted way.

xx. The Understanding when left to itself proceeds by the same way as that which it would have adopted under the guidance of Logic, namely, the first. For the mind is fond of starting off to generalities, that it may avoid labour, and after dwelling a little on a subject is fatigued by experiment. But these evils are augmented by Logic, for the sake of the ostentation of dispute.

xxi. The Understanding when left to itself in a man of a steady, patient, and reflecting disposition (especially when unimpeded by received doctrines), makes some attempt in the right way, but with little effect; since the Understanding, undirected and unassisted, is unequal to and unfit for the task of vanquishing the obscurity of things.

xxii. Each of these two ways begins from the senses and and particulars, and ends in the greatest generalities. But they are immeasurably different; for the one merely touches cursorily the limits of experiment, and particulars, whilst the other runs duly and regularly through them; the one from the very outset lays down some abstract and useless generalities, the other gradually rises to those principles which are really the most common in Nature.

xxiii. There is no small difference between the *Idols* of the human mind, and the *Ideas* of the divine mind; that is to say, between certain idle dogmas, and the real stamp and impression of created objects, as they are found in nature.

xxiv. Axioms determined upon in argument can never assist in the discovery of new Effects: for the subtilty of Nature is vastly superior to that of argument. But Axioms properly and regularly abstracted from particulars, easily point out and define new particulars, and therefore impart *activity to the* Sciences.

xxv. The Axioms now in use are derived from a scanty handful, as it were, of experience, and a few particulars of frequent occurrence, whence they are of much the same dimensions or extent as their origin. And if any neglected or unknown instance occurs, the Axiom is saved by some frivolous distinction, when it would be more consistent with truth to amend it.

xxvi. We are wont, for the sake of distinction, to call that human reasoning, which we apply to Nature, the *Anticipation of Nature* (as being rash and premature); and that which is properly deduced from things the *Interpretation of Nature.*

xxvii. *Anticipations* are sufficiently powerful in producing unanimity, for if men were all to become even uniformly mad, they might agree tolerably well with each other.

xxviii. *Anticipations* again will be assented to much more readily than *Interpretations*; because being deduced from a few instances, and these principally of familiar occurrence, they immediately hit the Understanding, and satisfy the imagination; whilst, on the contrary, *Interpretations*, being deduced from various subjects, and these widely dispersed, cannot suddenly strike the *understanding*; so that in common estimation, they must appear difficult and discordant, and almost like the mysteries of faith.

xxix. In Sciences founded on Opinions and dogmas it is right to make use of *Anticipations* and Logic, if you wish to force assent rather than things.

xxx. If all the capacities of all ages should unite and combine and transmit their labours, no great progress will be made in Learning by *Anticipations*; because the radical errors, and those which occur in the first process of the mind, are not cured by the excellence of subsequent means and remedies.

xxxi. It is in vain to expect any great progress in the Sciences by the superinducing or engrafting new matters upon old. An instauration must be made from the very foundations, if we do not wish to revolve for ever in a Circle, making only some slight and contemptible progress.

xxxii. The ancient Authors, and all others, are left in undisputed possession of their honours. For we enter into no comparison of capacity or talent but of method; and assume the part of a Guide rather than of a Critic.

xxxiii. To speak plainly, no correct judgment can be formed either of our method, or its discoveries by those *Anticipations* which are now in common use; for it is not to be required of us to submit ourselves to the judgment of the very method we ourselves arraign.

xxxiv. Nor is it an easy matter to deliver and explain our sentiments: for those things which are in themselves new can yet be only understood from some analogy to what is old.

xxxv. *Alexander Borgia* said of the expedition of the *French* into *Italy* that they came with chalk in their hands to mark up their lodgings, and not with weapons to force their passage. Even so do we wish our philosophy to make its way quietly into those minds that are fit for it, and of good capacity. For we have no need of Contention where we differ in first Principles, and in our very Notions, and even in our forms of Demonstration.

xxxvi. We have but one simple method of delivering our sentiments: namely, we must bring men to particulars, and their regular Series and Order, and they must for a while renounce their Notions and begin to form an acquaintance with things.

xxxvii. Our method and that of the *Sceptics* agree in some respects at first setting out: but differ most widely and are completely opposed to each other in their conclusion. For they roundly assert that nothing can be known; we, that but a small part of Nature can be known by the *present* method. Their next step however is to destroy the authority of the senses and understanding, whilst we invent and supply them with assistance.

xxxviii. The *Idols* and false Notions which have already preoccupied the human Understanding, and are deeply rooted in it, not only so beset men's Minds, that they become difficult of access, but even when access is obtained, will again meet and trouble us in the instauration of the Sciences, unless mankind, when forewarned, guard themselves with all possible care against them.

xxxix. Four species of *Idols* beset the human mind : to which (for distinction's sake) we have assigned names : calling the first *Idols of the Tribe ;* the second *Idols of the Den ;* the third *Idols of the Market ;* the fourth *Idols of the Theatre.*

xl. The formation of Notions and Axioms on the foundations of true *Induction*, is the only fitting remedy, by which we can ward off and expel these *Idols*. It is however of great service to point them out. For the Doctrine of *Idols* bears the same relation to the *Interpretation of Nature*, as that of the Confutation of Sophisms does to common Logic.

xli. The *Idols of the Tribe* are inherent in human Nature, and the very Tribe or race of man. For Man's Sense is falsely asserted to be the Standard of things. On the contrary, all the Perceptions, both of the Senses and the Mind, bear reference to man, and not to the Universe, and the human Mind resembles those uneven mirrors, which impart their own properties to different Objects, from which rays are emitted, and distort and disfigure them.

xlii. The *Idols of the Den* are those of each individual. For every body (in addition to the Errors common to the race of man) has his own individual Den or cavern, which intercepts and corrupts the light of Nature ; either from his own peculiar and singular disposition, or from his education and intercourse with others, or from his reading, and the authority acquired by those whom he reverences and admires, or from the different Impressions produced on the mind, as it happens to be preoccupied and predisposed, or equable and tranquil, and the like: so that the spirit of man (according to its several dispositions) is variable, confused, and as it were actuated by chance; and *Heraclitus* said well that men search for Knowledge in lesser Worlds and not in the greater or common world.

xliii. There are also *Idols* formed by the reciprocal intercourse and society of man with man, which we call *Idols of the Market*, from the commerce and association of men with each other. For Men converse by means of language; but words are formed at the will of the generality; and there arises from a bad and unapt formation of words a wonderful obstruction to the mind. Nor can the definitions and explanations, with which learned men are wont to guard and protect themselves in some instances, afford a complete remedy: words still manifestly force the understanding, throw everything into confusion, and lead mankind into vain and innumerable Controversies and fallacies.

xliv. Lastly, there are *Idols* which have crept into men's minds from the various Dogmas of peculiar systems of Philosophy, and also from the perverted rules of Demonstration, and these we denominate *Idols of the Theatre.* For we regard all the systems of Philosophy hitherto received or imagined, as so many plays brought out and performed, creating fictitious and theatrical Worlds. Nor do we speak only of the present systems, or of the Philosophy and Sects of the ancients, since numerous other plays of a similar nature can be still composed and made to agree with each other, the causes of the most opposite errors being generally the same. Nor, again, do we allude merely to the general systems, but also to many Elements and Axioms of Sciences, which have become inveterate by tradition, implicit credence, and neglect. We must, however, discuss each species of *Idols* more fully and distinctly in order to guard the human Understanding against them.

xlv.[1] The human Understanding, from its peculiar nature, easily supposes a greater degree of order and equality in things than it really finds; and although many things in Nature be sui generis, and most irregular, will yet invent Parallels and Conjugates, and Relatives where no such thing is. Hence the Fiction, *that all celestial bodies move in perfect circles*, thus rejecting entirely spiral and serpentine lines (except as explanatory terms). Hence also the element of Fire is introduced with its peculiar Orbit, to keep square with those other three which are objects of our senses. The relative rarity of the Elements (as they are called) is arbitrarily made to vary in tenfold progression, with many other dreams of the like nature. Nor is this folly confined to theories, but it is to be met with even in simple Notions.

xlvi. The human Understanding, when any proposition has been once laid down (either from general admission and belief, or from the pleasure it affords), forces everything else to add fresh support and confirmation; and although most cogent and abundant instances may exist to the contrary, yet either does not observe or despises them, or gets rid of and rejects them by some distinction, with violent and injurious prejudice, rather than sacrifice the authority of its first Conclusions. It was well answered by him who was shown in a temple the votive tablets suspended by such as had escaped the peril of shipwreck, and was pressed as to whether he would then recognise the Power of the Gods, by an inquiry; But *where are the portraits of those who have perished in spite of their vows?* All superstition is much the same, whether it be that of Astrology, Dreams, Omens, Retributive Judgment, or the like; in all of which the deluded believers observe events which are fulfilled, but neglect and pass over their failure, though it be much more common. But this evil insinuates itself still more craftily in Philosophy and the Sciences ; in which a settled maxim vitiates and governs every other circumstance, though the latter be much more worthy of confidence. Besides even in the absence of that eagerness and want of thought (which we have mentioned), it is the peculiar and perpetual error of the human understanding to be more moved and excited by Affirmatives than Negatives, whereas it ought duly and regularly to be impartial ; nay, in establishing any true Axiom, the negative instance is the most powerful.

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[1] *Hence to Aphorism* liii treats of the *Idols of the Tribe*.

xlvii. The human Understanding is most excited by that which strikes and enters the mind at once and suddenly, and by which the imagination is immediately filled and inflated. It then begins almost imperceptibly to conceive and suppose that every thing is similar to the few objects which have taken possession of the mind ; whilst it is very slow and unfit for the transition to the remote and heterogeneous instances, by which Axioms are tried as by fire, unless the office be imposed upon it by severe regulations and a powerful authority.

xlviii. The human Understanding is active and cannot halt or rest, but even, though without effect, still presses forward. Thus we cannot conceive of any end or external boundary of the World, and it seems necessarily to occur to us, that there must be something beyond. Nor can we imagine how eternity has flowed on down to the present day, since the usually received distinction of an infinity, *a parte ante* and *a parte post* cannot hold good : for it would thence follow that one infinity is greater than another, and also that infinity is wasting away and tending to an end. There is the same difficulty in considering the infinite divisibility of lines, arising from the weakness of our Minds, which weakness interferes to still greater disadvantage with the discovery of causes. For although the greatest generalities in Nature must be positive, just as they are found, and in fact not *causable*, yet the human Understanding, incapable of resting, seeks for something more intelligible. Thus, however, whilst aiming at further progress, it falls back to what is actually less advanced, namely, final causes; for they are clearly more allied to man's own nature, than the system of the Universe; and from this source they have wonderfully corrupted Philosophy. But he would be an unskilful and shallow philosopher, who should seek for causes in the greatest generalities, and not be anxious to discover them in subordinate objects.

xlix. The human Understanding resembles not a dry light, but admits a tincture of the will and passions, which generate their own system accordingly; for man always believes more readily that which he prefers. He therefore rejects difficulties for want of patience in investigation; sobriety, because it limits his hope; the depths of Nature, from superstition; the light of experiment, from arrogance and pride, lest his Mind should appear to be occupied with common and varying objects; paradoxes, from a fear of the Opinion of the vulgar; in short, his feelings imbue and corrupt his understanding in innumerable and sometimes imperceptible ways.

l. But by far the greatest impediment and aberration of the human Understanding proceeds from the dulness, incompetency, and errors of the Senses: since whatever strikes the Senses preponderates over every thing, however superior, which does not immediately strike them. Hence contemplation mostly ceases with sight; and a very scanty, or perhaps no regard is paid to invisible objects. The entire operation, therefore, of spirits enclosed in tangible bodies is concealed and escapes us. All that more delicate change of formation in the parts of coarser substances (*vulgarly called alteration*, but in fact a change of positio in the smallest particles) is equally unknown; and yet, unless the two matters we have mentioned be explored and brought to light, no great effect can be produced in Nature. Again, the very nature of common air, and all bodies of less density (of which there are many) is almost unknown. For the senses are weak and erring, nor can instruments be of great use in extending their sphere or acuteness; all the better interpretations of Nature are worked out by instances, and fit and apt experiments, where the Senses only judge of the experiment, the experiment of Nature and the thing itself.

li. The human Understanding is, by its own nature, prone to abstraction, and supposes that which is fluctuating to be fixed. But it is better to dissect than abstract Nature; such was the method employed by the School of *Democritus*, which made greater progress in penetrating Nature than the rest. It is best to consider Matter, its Conformation, and the Changes of that Conformation, its own Action, and the law of this Action or Motion: for Forms are a mere Fiction of the human mind, unless you will call *the laws of Action* by that name.

lii. Such are the *Idols of the Tribe*, which arise either from the uniformity of the constitution of man's spirit, or its prejudices, or its limited faculties, or restless Agitation, or from the interference of the passions, or the incompetency of the Senses, or the mode of their impressions.

liii. The *Idols of the Den* [1] derive their origin from the peculiar Nature of each individual's mind and body; and also from education, habit, and accident. And although they be various and manifold, yet we will treat of some that require the greatest Caution, and exert the greatest power in polluting the Understanding.

liv. Some men become attached to particular Sciences and Contemplations, either from supposing themselves the authors and inventors of them, or from having bestowed the greatest pains upon such subjects, and thus become most habituated to them. If men of this description apply themselves to Philosophy and Contemplations of an universal nature, they wrest and corrupt them by their preconceived Fancies; of which *Aristotle* affords us a signal instance, who made his Natural Philosophy completely subservient to his Logic, and thus rendered it little more than useless and disputatious. The Chemists, again, have formed a fanciful Philosophy with the most confined views, from a few experiments of the furnace. *Gilbert*, too, having employed himself most assiduously in the consideration of the Magnet, immediately established a system of Philosophy to coincide with his favourite pursuit.

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[1] *Hence to Aphorism* lix treats of the *Idols of the Den.*

lv. The greatest and, perhaps, radical distinction between different men's dispositions for Philosophy and the Sciences is this; that some are more vigorous and active in observing the differences of things, others in observing their resemblances. For a steady and acute Disposition can fix its thoughts and dwell upon and adhere to a point, through all the refinements of differences, but those that are sublime and discursive recognise and compare even the most delicate and general resemblances. Each of them readily falls into excess, by catching either at nice distinctions or shadows of resemblance.

lvi. Some dispositions evince an unbounded admiration of Antiquity, others eagerly embrace Novelty; and but few can preserve the just medium, so as neither to tear up what the Ancients have correctly laid down, nor to despise the just innovations of the Moderns. But this is very prejudicial to the sciences and Philosophy, and instead of a correct judgment, we have but the factions of the Ancients and Moderns. Truth is not to be sought in the good fortune of any particular conjuncture of time, which is uncertain, but in *the light of Nature* and experience, which is eternal. Such factions therefore, are to be abjured, and the understanding must not allow them to hurry it on to assent.

lvii. The Contemplation of Nature and of bodies in their individual form distracts and weakens the understanding: but the Contemplation of Nature and of bodies in their general composition and formation stupefies and relaxes it. We have a good instance of this in the school of *Leucippus* and *Democritus* compared with others: for they applied themselves so much to particulars as almost to neglect the general structure of Things, whilst the others were so astounded whilst gazing on the structure that they did not penetrate the simplicity of Nature. These two species of contemplation must therefore be interchanged, and each employed in its turn, in order to render the Understanding at once penetrating and capacious, and to avoid the inconveniences we have mentioned, and the *Idols* that result from them.

lviii. Let such, therefore, be our Precautions in contemplation, that we may ward off and expel the *Idols of the Den*: which mostly owe their birth either to some prominent pursuit; or, secondly, to an excess in synthesis and analysis; or, thirdly, to a party zeal in favour of certain ages; or, fourthly, to the extent or narrowness of the subject. In general he who contemplates Nature should suspect whatever particularly takes and fixes his Understanding, and should use so much the more caution to preserve it equable and unprejudiced.

lix. The *Idols of the Market*[1] are the most troublesome of all, those namely which have entwined themselves round the Understanding from the association of words and names. For men imagine that their reason governs words, whilst, in fact, words re-act upon the Understanding; and this has rendered Philosophy and the Sciences Sophistical and inactive. Words are generally formed in a popular sense, and define things by those broad lines which are most obvious to the vulgar mind; but when a more acute Understanding, or more diligent observation is anxious to vary those lines, and to adapt them more accurately to nature, words oppose it. Hence the great and solemn disputes of learned men often terminate in controversies about words and names, in regard to which it would be better (imitating the caution of Mathematicians) to proceed more advisedly in the first instance, and to bring such disputes to a regular issue by definitions. Such definitions, however, cannot remedy the evil in Natural and material objects, because they consist themselves of words, and these words produce others; so that we must necessarily have recourse to particular instances, and their regular series and arrangement, as we shall mention when we come to the mode and scheme of determining Notions and Axioms.

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[1] *Hence to Aphorism* lxi treats of the *Idols of the Market.*

lx. The *Idols* imposed upon the Understanding by words are of two kinds. They are either the names of things which have no existence (for as some objects are from inattention left without a name, so names are formed by fanciful imaginations which are without an object), or they are the names of actual objects, but confused, badly defined, and hastily and irregularly abstracted from things. Fortune, the Primum Mobile, the Planetary Orbits, the Element of Fire, and the like fictions, which owe their birth to futile and false theories, are instances of the first kind. And this species of *Idols* is removed with greater facility, because it can be exterminated by the constant refutation or the desuetude of the theories themselves. The others, which are created by vicious and unskilful abstraction, are intricate and deeply rooted. Take some word for instance, as *Moist*; and let us examine how far the different significations of this word are consistent. It will be found that the word *Moist* is nothing but a confused sign of different actions admitting of no settled and defined uniformity. For it means that which easily diffuses itself over another body; that which is indeterminable and cannot be brought to a consistency; that which yields easily in every direction; that which is easily divided and dispersed; that which is easily united and collected; that which easily flows and is put in motion; that which easily adheres to and wets another body; that which is easily reduced to a liquid state though previously solid. When, therefore, you come to predicate or impose this name, in one sense flame is moist, in another air is not moist, in another fine powder is moist, in another glass is moist; so that it is quite clear that this Notion is hastily abstracted from water only, and common ordinary liquors without any due verification of it.

There are, however, different degrees of distortion and mistake in words. One of the least faulty classes is that of the names of substances, particularly of the less abstract and more defined species (those then of chalk and mud are good, of earth, bad); words signifying actions are more faulty, as to *generate*, to *corrupt*, to *change*; but the most faulty are those denoting qualities (except the immediate objects of sense), as *heavy*, *light*, *rare*, *dense*. Yet in all of these there must be some Notions a little better than others, in proportion as a greater or less number of things come before the senses.

lxi. The *Idols of the Theatre*[1] are not innate, nor do they introduce themselves secretly into the understanding; but they are manifestly instilled and cherished by the fictions of theories and depraved rules of Demonstration. To attempt, however, or undertake their confutation would not be consistent with our declarations. For since we neither agree in our Principles nor our Demonstrations, all argument is out of the question. And it is fortunate that the Ancients are left in possession of their honours. We detract nothing from them, seeing our whole doctrine relates only to the path to be pursued. The Lame (as they say) in the path outstrip the swift who wander from it, and it is clear that the very skill and swiftness of him who runs not in the right direction must increase his aberration.

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[1] *Hence to Aphorism* lxviii treats of the *Idols of the Theatre.*

Our method of discovering the Sciences is such as to leave little to the acuteness and strength of wit, and indeed rather to level wit and Intellect. For as in the drawing of a straight line, or accurate circle by the hand, much depends on its steadiness and practice, but if a ruler or compass be employed there is little occasion for either; so it is with our method. Although, however, we enter into no individual confutations, yet a little must be said, first, of the sects and general divisions of these species of theories; secondly, something further to show that there are external signs of their weakness; and, lastly, we must consider the causes of so great a misfortune, and so long and general a unanimity in error, that we may thus render the access to truth less difficult, and that the human Understanding may the more readily be purified, and brought to dismiss its *Idols*.

lxii. The *Idols of the Theatre* or of Theories are numerous, and may and perhaps will be still more so. For unless men's minds had been now occupied for many ages in religious and Theological considerations, and Civil Governments (especially Monarchies) had been adverse to novelties of that nature even in theory (so that men must apply to them with some risk and injury to their own fortunes, and not only without reward but subject to contumely and envy,) there is no doubt that many other sects of Philosophers and Theorists would have been introduced, like those which formerly flourished in such diversified abundance amongst the *Greeks*. For as many imaginary theories of the heavens can be deduced from the *Phenomena* of the sky, so is it even more easy to found many *Dogmas* upon the *Phenomena* of Philosophy—and the *plot* of this our *Theatre* resembles those *of the Poetical*, where the plots which are invented for the Stage are more consistent, elegant, and pleasurable than those taken from real history.

In general men take for the groundwork of their Philosophy either too much from a few topics, or too little from many; in either case their Philosophy is founded on too narrow a basis of experiment and natural history, and decides on too scanty grounds. For the theoretic philosopher seizes various common circumstances by experiment, without reducing them to certainty or examining or frequently considering them, and relies for the rest upon meditation and the activity of his wit.

There are other Philosophers who have diligently and accurately attended to a few experiments, and have thence presumed to deduce and invent systems of Philosophy, forming every thing to conformity with them.

A third set from their faith and religious veneration introduce Theology and traditions ; the absurdity of some among them having proceeded so far, as to seek and derive the Sciences from Spirits and Genii. There are therefore three sources of error and three species of *False Philosophy ;* the *Sophistic*, *Empiric*, and *Superstitious.*

lxiii. *Aristotle* affords the most eminent instance of the first : for he corrupted Natural Philosophy by Logic—thus he formed the World of Categories, assigned to the human soul, the noblest of substances, a genus determined by words of secondary operation, treated of *density* and *rarity* (by which bodies occupy a greater or lesser space) by the frigid distinctions of Action and Power, asserted that there was a peculiar and proper motion in all bodies, and that if they shared in any other motion, it was owing to an external moving cause, and imposed innumerable arbitrary distinctions upon the Nature of things ; being every where more anxious as to definitions in teaching and the accuracy of the wording of his propositions, than the internal truth of things. And this is best shown by a comparison of his

Philosophy with the others of greatest repute among the *Greeks*. For the Similar Parts of *Anaxagoras*, the Atoms of *Leucippus* and *Democritus*, the Heaven and Earth of *Parmenides*, the Discord and Concord of *Empedocles*, the Resolution of bodies into the common nature of Fire, and their Condensation according to *Heraclitus*, exhibit some sprinkling of natural Philosophy, the nature of things, and experiment; whilst *Aristotle's* Physics are mere Logical terms, and he remodelled the same subject in his Metaphysics under a more imposing title, and more as a Realist than a Nominalist. Nor is much stress to be laid on his frequent recourse to experiment in his books on Animals, his Problems, and other treatises; for he had already decided, without having properly consulted experience as the basis of his Decisions and Axioms, and after having so decided, he drags experiment along as a captive constrained to accommodate herself to his decisions: so that he is even more to be blamed, than his modern followers (of the Scholastic School) who have deserted her altogether.

lxiv. The *Empiric* School produces dogmas of a more deformed and monstrous nature than the *Sophistic* or theoretic school: not being founded in the light of common notions (which, however poor and superficial, is yet in a manner universal and of a general tendency), but in the confined obscurity of a few experiments. Hence this species of Philosophy appears probable and almost certain to those who are daily practised in such experiments, and have thus corrupted their imagination, but incredible and futile to others. We have a strong instance of this in the Alchymists and their dogmas; it would be difficult to find another in this age, unless perhaps in the Philosophy of *Gilbert.*[1] We could not however neglect to caution others against this School, because we already foresee and augur, that if men be hereafter induced by our exhortations to apply seriously to experiments (bidding farewell to the Sophistic doctrines), there will then be imminent danger from empirics, owing to the premature and forward haste of the Understanding and its jumping or flying to generalities and the principles of things. We ought therefore already to meet the evil.

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[1] It is thus the Vulcanists and Neptunians have framed their opposite theories in geology. Phrenology is a modern instance of hasty generalization.

lxv. The Corruption of Philosophy by the mixing of it up with *Superstition* and Theology is of a much wider extent, and is most injurious to it both as a whole and in parts. For the human Understanding is no less exposed to the impressions of Fancy, than to those of vulgar notions. The disputatious and *Sophistic* School entraps the Understanding, whilst the fanciful, bombastic, and as it were Poetical school rather flatters it. There is a clear example of this among the *Greeks*, especially in *Pythagoras*, where however the *Superstition* is coarse and overcharged, but it is more dangerous and refined in *Plato* and his school. This evil is found also in some branches of other systems of Philosophy, where it introduces abstracted forms, final and first causes, omitting frequently the intermediate, and the like. Against it we must use the greatest caution ; for the *Apotheosis* of error is the greatest evil of all, and when folly is worshipped, it is, as it were, a plague spot upon the Understanding. Yet some of the moderns have indulged this folly with such consummate inconsiderateness, that they have endeavoured to build a system of natural Philosophy on the first chapter of *Genesis*, the book of *Job*, and other parts of Scripture ; seeking thus *the dead amongst the living*. And this folly is the more to be prevented and restrained, because not only fantastical Philosophy but heretical Religion spring from the absurd mixing of matters Divine and Human. It is therefore most wise soberly to render unto *faith the* things that are faith's.

lxvi. Having spoken of the vicious authority of the Systems founded either on *Vulgar notions*, or on a *few experiments*, or on *superstition*, we must now consider the faulty subjects for Contemplation, especially in Natural Philosophy. The human Understanding is perverted by observing the power of Mechanical Arts, in which bodies are very materially changed by composition or separation, and is induced to suppose that something similar takes place in the universal nature of things. Hence the fiction of Elements, and their co-operation in forming natural bodies. Again when man reflects upon the entire liberty of Nature, he meets with particular species of Things, as Animals, Plants, Minerals, and is thence easily led to imagine that there exist in Nature certain primary Forms which she strives to produce, and that all variation from them arises from some impediment or error which she is exposed to in completing her work, or from the collision or metamorphosis of different species. The first hypothesis has produced the doctrine of elementary properties, the second that of occult properties and specific powers: and both lead to trifling courses of reflection, in which the mind acquiesces, and is thus diverted from more important subjects. But Physicians exercise a much more useful labour in the consideration of the secondary qualities of things and the operations of Attraction, Repulsion, Attenuation, Inspissation, Dilatation, Astringency, Separation, Maturation, and the like: and would do still more if they would not corrupt these proper observations by the two systems I have alluded to, of elementary qualities and specific powers, by which they either reduce the secondary to first qualities, and their subtile and immeasurable composition, or at any rate neglect to advance by greater and more diligent observation to the third and fourth qualities, thus terminating their contemplation prematurely. Nor are these powers (or the like) to be investigated only among the medicines for

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the human body, but also in all changes of other natural bodies.

A greater evil arises from the contemplation and investigation rather of the stationary principles of things *from which*, than of the active *by which* things themselves are created. For the former only serve for discussion, the latter for practice. Nor is any value to be set on those common differences of Motion which are observed in the received system of Natural Philosophy, as *Generation*, *Corruption*, *Augmentation*, *Diminution*, *Alteration* and *Translation*. For this is their meaning: if a body, unchanged in other respects, is moved from its place, this is *Translation;* if the place and species be given, but the quantity changed, it is *Alteration;* but if, from such a change, the mass and quantity of the body do not continue the same, this is the motion of *Augmentation* and *Diminution;* if the change be continued so as to vary the species and substance, and transfuse them to others, this is *Generation* and *Corruption*. All this is merely popular, and by no means penetrates into Nature; and these are but the measures and bounds of motion, and not different species of it; they merely suggest *How far*, and not *How* or *Whence*.. For they exhibit neither the affections of bodies, nor the process of their parts, but merely establish a division of that motion, which coarsely exhibits to the senses matter in its varied form. Even when they wish to point out something relative to the causes of motion, and to establish a division of them, they most absurdly introduce *natural* and *violent* motion, which is also a popular notion, since every violent motion is also in fact *natural*, that is to say, the external efficient puts nature in action in a different manner to that which she had previously employed.

But if, neglecting these, any one were for instance to observe, that there is in bodies a tendency of adhesion so as not to suffer the unity of Nature to be completely separated or broken, and a vacuum to be formed; or that they have a tendency to return to their natural dimensions or tension, so that if compressed or extended within or beyond it, they immediately strive to recover themselves, and resume their former volume and extent; or that they have a tendency to congregate into masses with similar bodies, the dense, for instance, towards the Circumference of the Earth, the thin and rare towards that of the Heavens; these and the like are true Physical genera of Motions, but the others are clearly Logical and Scholastic, as appears plainly from a comparison of the two.

Another considerable evil is, that men in their Systems and contemplations bestow their labour upon the investigation and discussion of the Principles of things and the extreme Limits of nature, although all utility and means of action consist in the intermediate objects. Hence men cease not to abstract Nature till they arrive at potential and shapeless matter, and still persist in their Dissection, till they arrive at Atoms; and yet were all this true, it would be of little use to advance man's estate.

lxvii. The Understanding must also be cautioned against the intemperance of Systems, so far as regards its giving or withholding its assent; for such intemperance appears to fix and perpetuate *Idols*, so as to leave no means of removing them.

These excesses are of two kinds. The first is seen in those who *decide* hastily, and render the sciences positive and Dictatorial. The other in those who have introduced *Scepticism*, and vague unbounded inquiry. The former subdues, the latter enervates the Understanding. The *Aristotelian* Philosophy, after destroying other Systems (as the *Ottomans* do their brethren) by its disputatious confutations, decided upon every thing, and *Aristotle* himself then raises up *questions at will*, in order to settle them; so that every thing should be certain and decided, a method now in use among his succcessors.

The school of *Plato* introduced *Scepticism*, first, as it were, in joke and irony from their dislike to *Protagoras*, *Hippias*, and others, who were ashamed of appearing not to doubt upon any subject. But the new Academy dogmatized in their *Scepticism*, and held it as their tenet. Although this method be more honest than arbitrary *decision* (for its followers allege that they by no means confound all inquiry, like *Pyrrho* and his Disciples, but hold doctrines which they can follow as probable, though they cannot maintain them to be true)(yet when the human mind has once despaired of discovering truth, every thing begins to languish.) Hence men turn aside into pleasant controversies and discussions, and into a sort of wandering over subjects, rather than sustain any rigorous investigation. But as we observed at first, we are not to deny the authority of the human senses and understanding, although weak; but rather to furnish them with assistance.

lxviii. We have now treated of each kind of *Idols*, and their qualities; all of which must be abjured and renounced with firm and solemn resolution, and the Understanding must be completely freed and cleared of them; so that the access to the Kingdom of Man, which is founded on the Sciences, may resemble that to the Kingdom of Heaven, *where no admission is conceded except to children.*

lxix. Vicious demonstrations are the muniments and support of Idols, and those which we possess in Logic, merely subject and enslave the World to human thoughts, and thoughts to words. But Demonstrations are, in some manner, themselves systems of Philosophy and Science. For such as they are, and accordingly as they are regularly or improperly established, such will be the resulting systems of Philosophy and Contemplation. But those which we employ in the whole process leading from the senses and things to Axioms and Conclusions, are fallacious and incompetent. This Process is fourfold, and the errors are in equal number. In the first place the impressions of the senses are erroneous, for they fail and deceive us. We must supply defects by substitutions, and fallacies by their correction. 2dly. Notions are improperly abstracted from the senses, and indeterminate and confused when they ought to be the reverse. 3dly. The Induction that is employed is improper, for it determines the Principles of Sciences by simple enumeration, without adopting exclusions, and resolutions, or just separations of Nature. Lastly, the usual method of discovery and proof by first establishing the most general Propositions, then applying and proving the intermediate Axioms according to them, is the parent of error and the calamity of every Science. But we will treat more fully of that which we now slightly touch upon, when we come to lay down the true way of interpreting Nature, after having gone through the above expiatory process and purification of the Mind.

lxx. But Experience is by far the best demonstration, provided it adhere to the experiment actually made; for if that experiment be transferred to other subjects apparently similar, unless with proper and methodical caution, it becomes fallacious. The present method of experiment is blind and stupid. Hence men wandering and roaming without any determined course, and consulting mere chance, are hurried about to various points and advance but little; at one time they are happy, at another their attention is distracted, and they always find that they want something further. Men generally make their experiments carelessly, and as it were in sport, making some little variation in a known experiment, and then if they fail, they become disgusted and give up the attempt: nay, if they set to work more seriously, steadily, and assiduously, yet they waste all their time on probing some solitary matter; as *Gilbert* on the Magnet, and the Alchymists on gold. But such conduct shows their method to be no less unskilful than mean. For nobody can successfully investigate the nature of any object by considering that object alone, the inquiry must be more generally extended.

Even when men build any science and theory upon Experiment, yet they almost always turn with premature and hasty zeal to practice, not merely on account of the advantage and benefit to be derived from it, but in order to seize upon some security in a new undertaking of their not employing the remainder of their labour unprofitably; and by making themselves conspicuous, to acquire a greater name for their pursuit. Hence, like *Atalanta*, they leave the course to pick up the golden apple, interrupting their speed, and giving up the victory. But in the true course of Experiment, and in extending it to new effects, we should imitate the Divine Foresight and Order. For *God*, on the first day, only Created Light, and assigned a whole day to that work, without creating any material substance thereon. In like manner, we must first, by every kind of Experiment, elicit the discovery of Causes and true Axioms, and seek for Experiments which may afford light rather than profit. Axioms, when rightly investigated and established, prepare us not for a limited but abundant Practice, and bring in their train whole troops of Effects. But we will treat hereafter of the ways of experience which are not less beset and interrupted than those of Judgment; having spoken at present of common Experience only as a bad species of Demonstration, the order of our subject now requires some mention of those external signs of the weakness in practice of the received systems of Philosophy and Contemplation[1] which we referred to above, and of the Causes of a circumstance at first sight so wonderful and incredible. For the knowledge of these external signs prepares the way for assent, and the explanation of the Causes removes the wonder; and these two circumstances are of material use in extirpating more easily and gently the *Idols* from the Understanding.

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[1] *See Aph. lxi, towards* the end. The subject extends to Aph. lxxxviii.

lxxi. The sciences we possess have been principally derived from the *Greeks*; for the additions of the *Roman*, *Arabic*, or more Modern writers are but few, and of small importance; and such as they are, are founded on the basis of *Greek* invention. But the wisdom of the *Greeks* was professional and disputatious, and thus most adverse to the investigation of truth. The name therefore of Sophists, which the contemptuous spirit of those who deemed themselves Philosophers, rejected and transferred to the Rhetoricians *Gorgias*, *Protagoras*, *Hippias*, *Polus*, might well suit the whole tribe, such as *Plato*, *Aristotle*, *Zeno*, *Epicurus*, *Theophrastus*, and their successors *Chrysippus*, *Carneades*, and the rest. There was only this difference between them, the former were mercenary vagabonds, travelling about to different states, making a show of their wisdom and requiring pay; the latter, more dignified and noble, in possession of fixed habitations, opening schools, and teaching philosophy gratuitously. Both, however (though differing in other respects), were professorial, and reduced every subject to controversy, establishing and defending certain sects and dogmas of philosophy: so that their doctrines were nearly (what Dionysius not unaptly objected to *Plato*) *the talk of idle old men to ignorant youths*. But the more ancient *Greeks*, as *Empedocles*, *Anaxagoras*, *Leucippus*, *Democritus*, *Parmenides*, *Heraclitus*, *Xenophanes*, *Philolaus*, and the rest (for I omit *Pythagoras* as being superstitious), did not (that we are aware) open Schools; but betook themselves to the investigation of truth with greater silence, and with more severity and simplicity: that is, with less affectation and ostentation. Hence in our opinion they acted more advisedly, however their Works may have been eclipsed in course of time by those lighter productions which better correspond with and please the apprehensions and passions of the vulgar: for time, like a river, bears down to us that which is light and inflated, and sinks that which is heavy and solid. Nor were even these more ancient philosophers free from the National defect, but inclined too much to the ambition and vanity of forming a sect, and captivating public opinion; and we must despair of any inquiry after truth, when it condescends to such trifles. Nor must we omit the opinion or rather prophecy of an *Egyptian* Priest with regard to the *Greeks*, *That they would for ever remain children, without any antiquity of Knowledge, or Knowledge of Antiquity.* For they certainly have this in common with children, that they are prone to talking and incapable of generation, their Wisdom being loquacious, and unproductive of effects. Hence the external signs derived from the Origin and Birthplace of our present Philosophy are not favourable.

lxxii. Nor are those much better which can be deduced from the character of the Time and Age, than the former from that of the Country and Nation. For in that age the knowledge both of Time and of the World was confined and meagre, which is one of the worst evils for those who rely on Experience. They had not a thousand years of History, worthy of that Name, but mere fables and Ancient traditions. They were acquainted with but a small portion of the regions and countries of the world—for they indiscriminately called all nations situated far towards the North *Scythians*, all those to the West *Celts*; they knew nothing of *Africa* but the nearest part of *Ethiopia*, or of *Asia* beyond the *Ganges*, and had not even heard any sure and clear tradition of the regions of the New World. Besides, a vast number of climates and zones, in which innumerable nations live and breathe, were pronounced by them to be *uninhabitable; nay,* the travels of *Democritus*, *Plato*, and *Pyth-*

agoras, which were not extensive, but rather mere excursions from home, were considered as something vast. But in our times many parts of the New World, and every extremity of the Old are well known, and the mass of Experiments has been infinitely increased. Wherefore if external signs were to be taken from the time of the Nativity or procreation (as in Astrology), nothing extraordinary could be predicted of these early systems of Philosophy.

lxxiii. Of all Signs there is none more certain or worthy than that of the fruits produced—for the Fruits and Effects are the sureties and vouchers as it were for the Truth of Philosophy. Now from the systems of the *Greeks* and their subordinate divisions in particular branches of the Sciences during so long a period, scarcely one single Experiment can be culled that has a tendency to elevate or assist mankind, and can be fairly set down to the speculations and doctrines of their Philosophy. *Celsus* candidly and wisely confesses as much, when he observes that Experiments were first discovered in Medicine, and that men afterwards built their philosophical systems upon them, and searched for and assigned causes, instead of the inverse method of discovering and deriving Experiments from Philosophy and the knowledge of causes. It is not therefore wonderful that the *Egyptians* (who bestowed divinity and sacred honours on the authors of new Inventions) should have consecrated more images of Brutes than of Men; for the brutes by their natural instinct made many discoveries, whilst men derived but few from discussion and the conclusions of reason.

The industry of the Alchymists has produced some effect, by chance however and casualty, or from varying their Experiments (as Mechanics also do), and not from any regular art or Theory; the theory they have imagined rather tending to disturb than to assist Experiment. Those too who have occupied themselves with Natural Magic (as they term it) have *made but* few discoveries, and those of small import, and bordering on imposture. For which reason in the same manner as we are cautioned by Religion to show our Faith by our Works, we may very properly apply the principle to Philosophy, and judge of it by its Works; accounting that to be futile which is unproductive, and still more so, if instead of grapes and olives it yield but the thistle and thorns of dispute and contention.

lxxiv. Other Signs may be selected from the increase and progress of particular systems of Philosophy and the Sciences. For those which are founded on Nature grow and increase, whilst those which are founded on Opinion change and increase not. If therefore the Theories we have mentioned were not like Plants torn up by the roots, but grew in the womb of Nature and were nourished by her; that which for the last two thousand years has taken place would never have happened: namely, that the Sciences still continue in their beaten track, and nearly stationary, without having received any important increase: nay, having on the contrary rather bloomed under the hands of their first Author and then faded away. But we see that the case is reversed in the Mechanical Arts, which are founded on Nature and the light of Experience, for they (as long as they are popular) seem full of life, and uninterruptedly thrive and grow, being at first rude, then convenient, lastly polished, and perpetually improved.

lxxv. There is yet another Sign (if such it may be termed, being rather an Evidence, and one of the strongest nature), namely, the actual Confession, of those very Authorities whom men now follow. For even they who decide on things so daringly, yet at times, when they reflect, betake themselves to complaints about the subtilty of Nature, the obscurity of Things, and the weakness of Man's wit. If they would merely do this, they might perhaps deter those who are of a timid disposition from further *inquiry, but would* excite and stimulate those of a more active and confident turn to further advances. They are not, however, satisfied with confessing so much of themselves, but consider every thing which has been either unknown or unattempted by themselves or their Teachers, as beyond the limits of Possibility; and thus, with most consummate pride and envy, convert the defects of their own discoveries into a calumny on Nature, and a source of despair to every one else. Hence arose the new Academy, which openly professed *Scepticism* and consigned mankind to eternal darkness. Hence the notion that Forms, or the true Differences of things (which are in fact the laws of simple Action), are beyond man's reach, and cannot possibly be discovered. Hence those notions in the Active and Operative branches; that the Heat of the Sun and of Fire are totally different, so as to prevent men from supposing that they can elicit or form, by means of Fire, any thing similar to the operations of Nature; and again, that Composition only is the work of Man and Mixture of Nature, so as to prevent men from expecting the generation or transformation of natural Bodies by art. Men will, therefore, easily allow themselves to be persuaded by this sign, not to engage their fortunes and labour in speculations, which are not only desperate, but actually devoted to desperation.

lxxvi. Nor should we omit the Sign afforded by the great dissension formerly prevalent among Philosophers, and the variety of Schools, which sufficiently show that the way was not well prepared, that leads from the Senses to the Understanding, since the same ground-work of philosophy (namely, the Nature of things) was torn and divided into such widely differing and multifarious errors. And although in these days the dissensions and differences of opinions with regard to first Principles and entire Systems are nearly extinct, yet there remain innumerable questions and controversies, with regard to particular branches of philosophy. So that *it is manifest that* there is nothing sure or sound either in the Systems themselves, or in the methods of Demonstration.

lxxvii. With regard to the supposition that there is a general Unanimity as to the Philosophy of *Aristotle*, because the other Systems of the Ancients ceased and became obsolete on its promulgation, and nothing better has been since discovered ; whence it appears that it is so well determined and founded as to have united the suffrages of both ages ; we will observe—1st. That the notion of other Ancient Systems having ceased after the publication of the Works of *Aristotle* is false, for the works of the ancient Philosophers subsisted long after that event, even to the time of *Cicero* and the subsequent ages. But at a later period, when human Learning had, as it were, been wrecked in the inundation of Barbarians into the *Roman* empire, then the Systems of *Aristotle* and *Plato* were preserved in the waves of ages, like planks of a lighter and less solid nature. 2nd. The notion of Unanimity on a clear inspection is found to be fallacious. For true Unanimity is that which proceeds from a free judgment arriving at the same conclusion after an investigation of the fact. Now by far the greater number of those who have assented to the Philosophy of *Aristotle*, have bound themselves down to it, from prejudice and the authority of others, so that it is rather obsequiousness and concurrence than Unanimity. But even if it were real and extensive Unanimity, so far from being esteemed a true and solid Confirmation, it should even lead to a violent presumption to the contrary. For there is no worse augury in Intellectual matters than that derived from Unanimity, with the exception of Divinity and Politics, where suffrages are allowed to decide. For nothing pleases the multitude, unless it strike the imagination or bind down the Understanding, as we have observed above, with the shackles of vulgar notions. Hence we may well transfer *Phocion's remark* from Morals to the Intellect : *That men should immediately examine what error or fault they have committed,* *when the multitude concurs with and applauds them.* This then is one of the most unfavourable Signs. All the Signs, therefore, of the truth and soundness of the received systems of Philosophy and the Sciences are unpropitious, whether taken from their Origin, their Fruits, their Progress, the Confessions of their Authors, or from Unanimity.

lxxviii. We now come to the Causes of Errors,[1] and of such perseverance in them for ages. These are sufficiently numerous and powerful to remove all wonder that what we now offer should have so long been concealed from and have escaped the notice of mankind, and to render it more worthy of astonishment, that it should even now have entered any one's mind or become the subject of his thoughts; and that it should have done so, we consider rather the gift of Fortune than of any extraordinary Talent, and as the offspring of Time rather than Wit. But, in the first place, the number of ages is reduced to very narrow limits on a proper consideration of the matter. For out of twenty-five Centuries, with which the memory and learning of man are conversant scarcely six can be set apart and selected as fertile in Science and favourable to its progress. For there are deserts and wastes in Times as in Countries, and we can only reckon up three revolutions and epochs of Philosophy. 1. The *Greek*. 2. The *Roman*. 3. Our own, that is the philosophy of the Western nations of *Europe*: and scarcely two Centuries can with justice be assigned to each. The intermediate Ages of the world were unfortunate both in the quantity and richness of the Sciences produced. Nor need we mention the *Arabs* or the Scholastic Philosophy which, in those ages, ground down the Sciences by their numerous treatises more than they increased their weight. The first Cause then of such insignificant progress in the Sciences is rightly referred to the small proportion of Time which has been *favourable thereto.*

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[1] *See end of Aph. lxi.* This subject extends to Aph. xc.

lxxix. A second Cause offers itself, which is certainly of the greatest importance; namely, that in those very ages in which men's wit and literature flourished considerably, or even moderately, but a small part of their industry was bestowed on Natural Philosophy, the great mother of the Sciences. For every Art and Science torn from this root may, perhaps, be polished and put into a serviceable shape, but can admit of little growth. It is well known, that after the *Christian* religion had been acknowledged and arrived at maturity, by far the best wits were busied upon Theology, where the highest rewards offered themselves, and every species of assistance was abundantly supplied, and the study of which was the principal occupation of the Western *European* nations during the third epoch; the rather because literature flourished about the very time when controversies concerning Religion first began to bud forth. 2. In the preceding ages, during the second epoch (that of the *Romans*) Philosophical meditation and labour were chiefly occupied and wasted in Moral Philosophy (the Theology of the Heathens): besides the greatest minds in these times applied themselves to Civil affairs, on account of the magnitude of the *Roman* Empire, which required the labour of many. 3. The age during which Natural Philosophy appeared principally to flourish among the *Greeks* was but a short period, since in the more ancient Times the seven Sages (with the exception of *Thales*) applied themselves to Moral Philosophy and Politics, and at a later period after *Socrates* had brought down Philosophy from heaven to earth, Moral Philosophy became more prevalent, and diverted men's attention from Natural. Nay, the very period during which physical inquiries flourished, was corrupted and rendered useless by contradictions and the ambition of new opinions. Since, therefore, during these three epochs, Natural Philosophy has been materially *neglected or impeded*, it is not at all surprising that men should have made but little progress in it, seeing they were attending to an entirely different matter.

lxxx. Add to this that Natural Philosophy, especially of late, has seldom gained exclusive possession of an individual free from all other pursuits, even amongst those who have applied themselves to it, unless there may be an example or two of some Monk studying in his cell, or some Nobleman in his villa. She has rather been made a passage and bridge to other pursuits.

Thus has this great Mother of the Sciences been degraded most unworthily to the situation of an Handmaid, and made to wait upon Medicine or Mathematical operations, and to wash the immature minds of youth, and imbue them with a first dye, that they may afterwards be more ready to receive and retain another. In the mean time let no one expect any great progress in the Sciences (especially their Operative part), unless Natural Philosophy be applied to particular Sciences, and particular sciences again referred back to Natural Philosophy. For want of this, Astronomy, Optics, Music, many Mechanical Arts, Medicine itself, and (what perhaps is more wonderful) Moral and Political Philosophy, and the Logical Sciences have no depth, but only glide over the surface and variety of things; because these Sciences, when they have been once partitioned out and established, are no longer nourished by Natural Philosophy, which would have imparted fresh vigour and growth to them from the sources and genuine contemplation of Motion, Rays, Sounds, Texture, and Conformation of Bodies, and the Affections and capacity of the Understanding. But we can little wonder that the Sciences grow not when separated from their roots.

lxxxi. There is another powerful and great cause of the little advancement of the Sciences, which is this; it is impossible to advance properly in the course when the Goal is not *properly fixed. But* the real and legitimate Goal of

Sciences is the endowment of human life with new Inventions and riches. The great crowd of teachers know nothing of this, but consist of dictatorial hirelings ; unless it so happen that some artisan of an acute genius and ambitious of fame gives up his time to a new Discovery, which is generally attended with a loss of property. The majority, so far from proposing to themselves the augmentation of the Mass of Arts and Sciences, make no other use of an inquiry into the Mass already before them, than is afforded by the conversion of it to some use in their lectures, or to gain, or to the acquirement of a name and the like. But if one out of the multitude be found, who courts Science from real zeal and on its own account, even he will be seen rather to follow contemplation and the variety of theories than a severe and strict investigation of truth. Again, if there even be an unusually strict investigator of truth, yet will he propose to himself as the test of truth the satisfaction of his Mind and Understanding as to the causes of things long since known, and not such a test as to lead to some new earnest of effects, and a new light in Axioms. If therefore no one have laid down the real end of Science, we cannot wonder that there should be error in points subordinate to that end.

lxxxii. But in like manner as the end and Goal of Science is ill defined, so even were the case otherwise men have chosen an erroneous and impassable direction. For it is sufficient to astonish any reflecting mind, that nobody should have cared or wished to open and complete a way for the Understanding, setting off from the senses, and regular well conducted experiment ; but that every thing has been abandoned either to the mists of tradition, the whirl and confusion of argument, or the waves and mazes of chance, and desultory ill-combined experiment. Now let any one but consider soberly and diligently the nature of the path men have been accustomed to pursue in the investigation and discovery of any matter, and he will doubtless first observe the rude and inartificial manner of discovery most familiar to mankind : which is no other than this. When any one prepares himself for discovery, he first inquires and obtains a full account of all that has been said on the subject by others, then adds his own reflections, and stirs up, and, as it were, invokes his own spirit, after much Mental labour, to disclose its oracles. All which is a method without foundation and merely turns on opinion.

Another perhaps calls in Logic to assist him in discovery, which bears only a nominal relation to his purpose. For the Discoveries of Logic are not discoveries of Principles and leading Axioms, but only of what appears to accord with them. And when men become curious and importunate and give trouble, interrupting her about her proofs and the discovery of Principles or first Axioms, she puts them off with her usual answer, referring them to faith and ordering them to swear Allegiance to each Art in its own department.

There remains but mere Experience, which when it offers itself is called Chance; when it is sought after, Experiment. But this kind of Experience is nothing but a loose faggot, and mere groping in the dark, as men at night try all means of discovering the right road, whilst it would be better and more prudent either to wait for day or procure a light and then proceed. On the contrary the real order of Experience begins by setting up a light, and then shows the road by it, commencing with a regulated and digested, not a misplaced and vague course of Experiment, and thence deducing Axioms, and from those Axioms new Experiments : for not even the Divine word proceeded to operate on the general Mass of things without due order.

Let men therefore cease to wonder if the whole course of Science be not run, when all have wandered from the path; *quitting entirely* and deserting Experience, or involving themselves in its Mazes, and wandering about; whilst a regularly combined System would lead them in a sure track through its wilds to the open day of Axioms.

lxxxiii. The evil however has been wonderfully increased by an opinion, or inveterate conceit, which is both vainglorious and prejudicial, namely, that the Dignity of the human Mind is lowered by long and frequent intercourse with experiments and particulars, which are the objects of sense and confined to matter; especially since such matters generally require labour in investigation, are mean subjects for meditation, harsh in discourse, unproductive in practice, infinite in number, and delicate in their subtilty. Hence we have seen the true path not only deserted but intercepted and blocked up, Experience being rejected with disgust, and not merely neglected or improperly applied.

lxxxiv. Again, the Reverence for Antiquity and the authority of men who have been esteemed great in Philosophy, and general Unanimity, have retarded men from advancing in Science, and almost enchanted them. As to Unanimity, we have spoken of it above.

The opinion which men cherish of Antiquity is altogether idle, and scarcely accords with the term. For the old age and increasing years of the World should in reality be considered as Antiquity, and this is rather the character of our own times than of the less advanced age of the World in those of the Ancients. For the latter, with respect to ourselves, are ancient and elder, with respect to the world modern and younger. And as we expect a greater knowledge of human affairs and more mature judgment from an old man than from a Youth, on account of his Experience, and the variety and number of things he has seen, heard, and meditated upon; so we have reason to expect much greater things of our own age (if it knew but its strength and would *essay and exert it*) than from antiquity, since the World has grown older, and its stock has been increased and accumulated with an infinite number of experiments and observations.

We must also take into consideration that many objects in Nature fit to throw light upon Philosophy have been exposed to our view and discovered by means of long voyages and travels, in which our times have abounded. It would indeed be dishonourable to mankind, if the regions of the material globe, the Earth, the Sea, and Stars should be so prodigiously developed and illustrated in our age, and yet the boundaries of the Intellectual globe should be confined to the narrow discoveries of the ancients.

With regard to authority, it is the greatest weakness to attribute infinite credit to particular Authors, and to refuse his own prerogative to Time, the Author of all authors, and, therefore, of all authority. For Truth is rightly named the daughter of Time, not of Authority. Is it not wonderful, therefore, if the bonds of Antiquity, Authority, and Unanimity have so enchained the power of man, that he is unable (as if bewitched) to become familiar with things themselves?

lxxxv. Nor is it only the admiration of Antiquity, ✓
Authority, and Unanimity, that has forced man's industry ✓
to rest satisfied with present discoveries, but also the admiration of the effects already placed within his power. For whoever passes in review the variety of subjects, and the beautiful apparatus collected and introduced by the Mechanical Arts for the service of mankind, will certainly be rather inclined to admire our wealth than to perceive our poverty: not considering that the observations of man and operations of Nature (which are the souls and first Movers of that variety) are few, and not of deep research; the rest must be attributed merely to man's patience and the delicate and well regulated motion of the Hand or of instruments. To take an *instance, the* manufactory of clocks is delicate and

accurate, and appears to imitate the heavenly bodies in its wheels and the pulse of animals in its regular oscillation, yet it only depends upon one or two Axioms of Nature.

Again, if one consider the refinement of the Liberal Arts, or even that exhibited in the preparation of natural bodies in Mechanical Arts and the like; as the discovery of the heavenly motions in Astronomy, of Harmony in Music, of the letters of the Alphabet (still unadopted by the *Chinese*) in Grammar; or, again, in Mechanical Operations, the productions of *Bacchus* and *Ceres*, that is the preparation of wine and beer, the making of bread, or even the luxuries of the Table, distillation, and the like; if one reflect also and consider for how long a period of ages (for all the above, except distillation, are ancient) these things have been brought to their present state of perfection, and (as we instanced in clocks) to how few observations and Axioms of Nature they may be referred, and how easily, and, as it were, by obvious chance or contemplation they might be discovered, one would soon cease to admire and rather pity the human lot on account of its vast want and dearth of things and Discoveries for so many ages. Yet even the discoveries we have mentioned were more ancient than Philosophy, and the Intellectual Arts; so that (to say the truth) when contemplation and doctrinal Science began, the Discovery of useful works ceased.

But if any one turn from the Manufactories to Libraries, and be inclined to admire the immense variety of books offered to our view let him but examine and diligently inspect the matter and contents of these books, and his astonishment will certainly change its object: for when he finds no end of repetitions, and how much men do and speak the same thing over again, he will pass from admiration of this variety to astonishment at the poverty and scarcity of matter, which has hitherto possessed and filled men's minds.

But if any one should condescend to consider such sciences as are deemed rather curious than sound, and take a full view of the operations of the Alchymists or Magi, he will perhaps hesitate whether he ought rather to laugh or to weep. For the Alchymist cherishes eternal hope, and when his labours succeed not, accuses his own mistakes, deeming in his self-accusation, that he has not properly understood the words of Art or of his Authors; upon which he listens to tradition and vague whispers, or imagines there is some slight unsteadiness in the minute details of his practice, and then has recourse to an endless repetition of Experiments: and in the mean time when, in his casual Experiments, he falls upon something in appearance new, or of some degree of utility, he consoles himself with such an earnest, and ostentatiously publishes them, keeping up his hope of the final result. Nor can it be denied that the Alchymists have made several Discoveries, and presented mankind with useful inventions. But we may well apply to them the fable of the Old Man, who bequeathed to his sons some gold buried in his garden, pretending not to know the exact spot, whereupon they worked diligently in digging the vineyard, and though they found no gold, the vintage was rendered more abundant by their labour.

The Followers of Natural Magic, who explain every thing by Sympathy and Antipathy, have assigned false powers and marvellous operations to things, by gratuitous and idle conjectures: and if they have ever produced any effects, they are rather wonderful and novel than of any real benefit or utility.

In superstitious Magic (if we say any thing at all about it), we must chiefly observe, that there are only some peculiar and definite objects with which the curious and superstitious Arts have in every Nation and age, and even under every religion, been able to exercise and amuse themselves. Let *us, therefore*, pass them over. In the mean time we cannot wonder that the false notion of Plenty should have occasioned Want.

lxxxvi. The admiration of mankind with regard to the Arts and Sciences, which is of itself sufficiently simple and almost puerile, has been increased by the craft and artifices of those who have treated the Sciences and delivered them down to posterity. For they propose and produce them to our view so fashioned and as it were masked, as to make them pass for perfect and complete. For if you consider their Method and divisions, they appear to embrace and comprise every thing which can relate to the subject. And although this frame be badly filled up and resemble an empty Bladder, yet it presents to the vulgar Understanding the form and appearance of a perfect Science.

The first and most Ancient Investigators of truth were wont, on the contrary, with more honesty and success, to throw all the knowledge they wished to gather from contemplation, and to lay up for use, into *Aphorisms*, or short scattered sentences unconnected by any Method, and without pretending or professing to comprehend any entire Art. But according to the present system, we cannot wonder that men seek nothing beyond that which is handed down to them as perfect, and already extended to its full complement.

lxxxvii. The Ancient theories have received additional support and credit from the absurdity and levity of those who have promoted the new, especially in the active and practical part of Natural Philosophy. For there have been many silly and fantastical fellows who, from credulity or imposture, have loaded mankind with promises, announcing and boasting of the Prolongation of life, the retarding of Old Age, the alleviation of pains, the remedying of Natural defects, the deception of the Senses, the restraint and excitement of the Passions, the illumination and exaltation *of the intellectul* faculties, the transmutation of Substances, the unlimited intensity and multiplication of Motion, the impressions and changes of the Air, the bringing into our power the management of Celestial Influences, the divination of future events, the representation of distant objects, the revelation of hidden objects, and the like. One would not be very wrong in observing with regard to such Pretenders, that there is as much difference in Philosophy, between their absurdity and real Science, as there is in history between the exploits of *Cæsar* or *Alexander*, and those of *Amadis de Gaul* and *Arthur of Britain*. For those illustrious Generals are found to have actually performed greater exploits than such fictitious Heroes are even pretended to have accomplished, by the means, however, of real action, and not by any fabulous and portentous power. Yet it is not right to suffer our belief in true history to be diminished, because it is sometimes injured and violated by fables. In the mean time we cannot wonder that great prejudice has been excited against any new propositions (especially when coupled with any mention of effects to be produced), by the conduct of impostors who have made a similar attempt, for their extreme absurdity and the disgust occasioned by it, have even to this day overpowered every spirited attempt of the kind.

lxxxviii. Want of energy, and the littleness and futility of the tasks that human industry has undertaken, have produced much greater injury to the Sciences: and yet (to make it still worse) that very want of energy manifests itself in conjunction with arrogance and disdain.

For, in the first place, one excuse, now from its repetition, become familiar, is to be observed in every Art, namely, that its Promoters convert the weakness of the Art itself into a calumny upon Nature: and whatever it in their hands fails to effect, they pronounce to be Physically impossible. But how can the Art ever be condemned whilst it acts as judge *in its own cause?* Even the present system of

Philosophy cherishes in its bosom certain positions or dogmas, which (it will be found on diligent inquiry) are calculated to produce a full conviction that no difficult, commanding, and powerful operation upon Nature ought to be anticipated through the means of Art; we instanced[1] above the alleged Different Quality of Heat in the Sun and Fire, and Composition and Mixture. Upon an accurate observation the whole tendency of such positions is wilfully to circumscribe man's power, and to produce a despair of the means of invention and contrivance, which would not only confound the promises of hope, but cut the very springs and sinews of industry, and throw aside even the chances of Experience. The only object of such philosophers is to acquire the reputation of perfection for their own Art, and they are anxious to obtain the most silly and abandoned renown, by causing a belief that whatever has not yet been invented and understood can never be so hereafter. But if any one attempt to give himself up to things, and to discover something new, yet he will only propose and destine for his object the investigation and discovery of some one Invention, and nothing more; as the nature of the Magnet, the Tides, the Heavenly System and the like, which appear enveloped in some degree of mystery, and have hitherto been treated with but little success. Now it is the greatest proof of want of skill, to investigate the nature of any object in itself alone; for that same Nature, which seems concealed and hidden in some instances, is manifest and almost palpable in others; and excites wonder in the former, whilst it hardly attracts attention in the latter. Thus the Nature of Consistency is scarcely observed in wood or stone, but passed over by the term *solid* without any further inquiry about the repulsion of separation or the solution of continuity. But in Water-bubbles the same circumstance appears matter of delicate and ingenious research, for they form themselves into thin pellicles, curiously shaped into Hemispheres, so as for an instant to avoid the solution of continuity.

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[1] See Aphorism lxxv.

In general those very things which are considered as secret, are manifest and common in other objects, but will never be clearly seen if the Experiments and contemplation of man be directed to themselves only. Yet it commonly happens, that if, in the Mechanical Arts, any one bring old Discoveries to a finer polish, or more elegant height of ornament, or unite and compound them, or apply them more readily to practice, or exhibit them on a less heavy and voluminous scale, and the like, they will pass off as new.

We cannot, therefore, wonder that no magnificent Discoveries, worthy of mankind, have been brought to light, whilst men are satisfied and delighted with such scanty and puerile tasks, nay even think that they have pursued or attained some great object in their accomplishment.

lxxxix. Nor should we neglect to observe that Natural Philosophy has, in every age, met with a troublesome and difficult opponent: I mean Superstition, and a blind and immoderate zeal for Religion. For we see that among the *Greeks* those who first disclosed the natural causes of Thunder and Storms to the yet untrained ears of man, were condemned as guilty of impiety towards the Gods. Nor did some of the old Fathers of *Christianity* treat those much better who showed by the most positive proofs (such as no one now disputes) that the Earth is spherical, and thence asserted that there were Antipodes.

Even in the present state of things the condition of discussions on Natural philosophy is rendered more difficult and dangerous by the Summaries and Methods of Divines, who, after reducing Divinity into such order as they could, and bringing it into a Scientific form, have proceeded to mingle an undue proportion of the contentious and thorny Philosophy of *Aristotle* with the Substance of Religion.

The *fictions of* those who have not feared to dedu and confirm the Truth of the *Christian* Religion by the Principles and Authority of Philosophers, tend to the same end though in a different manner. They celebrate the union of Faith and the Senses as though it were legitimate, with great pomp and solemnity, and gratify men's pleasing minds with a variety, but, in the mean time, confound most improperly things Divine and Human. Moreover, in these Mixtures of Divinity and Philosophy the received doctrines of the latter are alone included, and any novelty, even though it be an improvement, scarcely escapes banishment and extermination.

In short, you may find all access to any species of Philosophy, however pure, intercepted by the ignorance of Divines. Some, in their simplicity, are apprehensive that a too deep inquiry into Nature may penetrate beyond the proper bounds of decorum, transferring and absurdly applying what is said of sacred Mysteries in Holy Writ against those who pry into divine secrets, to the mysteries of Nature, which are not forbidden by any prohibition. Others, with more cunning, imagine and consider that if secondary causes be unknown, every thing may more easily be referred to the divine hand and wand ; a matter, as they think, of the greatest consequence to Religion, but which can only really mean that *God wishes to be gratified by means of falsehood.* Others fear, from past example, lest motion and change in Philosophy should terminate in an attack upon Religion. Lastly, there are others who appear anxious lest there should be something discovered in the investigation of Nature to overthrow, or at least shake, Religion, particularly among the unlearned. The two last apprehensions appear to resemble animal instinct, as if men were diffident, in the bottom of their minds, and secret meditations, of the strength of Religion, and the empire of Faith over the Senses ; and therefore feared that some danger awaited them from an *inquiry into Nature.* But any one who properly considers the subject, will find Natural Philosophy to be, after the Word of *God*, the surest remedy against Superstition, and the most approved support of Faith. She is therefore rightly bestowed upon Religion as a most faithful Attendant, for the one exhibits the Will and the other the Power of *God*. Nor was he wrong who observed, *Ye err, not knowing the Scriptures and the Power of God*; thus uniting in one bond the revelation of his Will, and the contemplation of his Power. In the mean while it is not wonderful that the progress of Natural Philosophy has been restrained, since Religion, which has so much influence on men's minds, has been led and hurried to oppose her through the ignorance of some and the imprudent zeal of others.

xc. Again, in the habits and regulations of Schools, Universities, and the like Assemblies, destined for the abode of learned men, and the improvement of learning, everything is found to be opposed to the progress of the Sciences. For the Lectures and Exercises are so ordered, that any thing out of the common track can scarcely enter the thoughts and contemplations of the mind. If, however, one or two have perhaps dared to use their liberty, they can only impose the labour on themselves, without deriving any advantage from the association of others: and if they put up with this, they will find their industry and spirit of no slight disadvantage to them in making their fortune. For the Pursuits of men in such situations are, as it were, chained down to the writings of particular Authors, and if any one dare to dissent from them, he is immediately attacked as a turbulent and revolutionary spirit. Yet how great is the difference between Civil Matters and the Arts; for there is not the same danger from new activity and new light. In Civil matters even a change for the better is suspected on account of the commotion it occasions; for Civil government is supported by authority, unanimity, fame, and public opinion, and not by demonstration. In the Arts and Sciences, on the contrary, every department should resound, as in mines, with new Works and advances. And this is the Rational, though not the actual, view of the case: for that administration and Government of Science we have spoken of, is wont too rigorously to repress its growth.

xci. And even should the odium I have alluded to be avoided, yet it is sufficient to repress the increase of Science that such attempts and industry pass unrewarded. For the cultivation of Science and its reward belong not to the same individual. The advancement of Science is the work of a powerful Genius, the prize and reward belong to the Vulgar or to Princes who (with a few exceptions) are scarcely moderately well informed. Nay such progress is not only deprived of the rewards and beneficence of individuals, but even of popular praise: for it is above the reach of the generality, and easily overwhelmed and extinguished by the weeds of common opinions. It is not wonderful therefore that little success has attended that which has been little honoured.

xcii. By far the greatest obstacle to the advancement of the Sciences and the undertaking of any new attempt or department is to be found in men's despair and the idea of Impossibility. For men of a prudent and exact turn of thought are altogether diffident in *Matters* of this nature, considering the obscurity of Nature, the shortness of Life, the deception of the Senses and weakness of the Judgment. They think therefore that in the revolutions of ages and of the World there are certain floods and ebbs of the Sciences, and that they grow and flourish at one time, and wither and fall off at another, that when they have attained a certain degree and condition they can proceed no further.

If therefore any one believe or promise greater things, they impute it to an uncurbed and immature mind, and imagine that such efforts begin pleasantly, then become laborious and end in confusion. And since such thoughts easily enter the minds of men of dignity and excellent judgment, we must really take heed lest we should be captivated by our affection for an excellent and most beautiful object, and relax or diminish the severity of our judgment ! and we must diligently examine what gleam of hope shines upon us, and in what direction it manifests itself, so that banishing her lighter dreams we may discuss and weigh whatever appears of more sound importance. We must consult the Prudence of *Ordinary Life* too, which is diffident upon principle, and in all human matters augurs the worst. Let us then speak of Hope, especially as we are not vain promisers nor are willing to force or ensnare men's judgment, but would rather lead them willingly forward. And although we shall employ the most cogent means of enforcing hope when we bring them to particulars, and especially those which are digested and arranged in our Tables of Invention, (the subject partly of the second but principally of the fourth part of the *Instauration*) which are indeed rather the very object of our hopes than hope itself ; yet to proceed more leniently we must treat of the Preparation of men's minds, of which the manifestation of Hope forms no slight part. For without it all that we have said tends rather to produce a gloom than to encourage activity or quicken the industry of experiment, by causing them to have a worse and more contemptuous opinion of things as they are than they now entertain, and to perceive and feel more thoroughly their unfortunate condition. We must therefore disclose and prefix our Reasons for not thinking the hope of success improbable ; as *Columbus*, before his wonderful voyage over the *Atlantic*, gave the reasons of his conviction that new Lands and Continents might be discovered besides those already known. And these reasons though at first rejected, were yet proved by subsequent experience, and were the causes and beginnings of the *greatest events.*

xciii. Let us begin from *God*, and show that our pursuit from its exceeding Goodness clearly proceeds from him, the Author of Good and Father of light. Now in all divine works, the smallest beginnings lead assuredly to some result, and the remark in Spiritual matters that *The kingdom of God cometh without observation* is also found to be true in every great Work of divine Providence ; so that everything glides quietly on without confusion or noise, and the matter is achieved before men either think or perceive that it is commenced. Nor should we neglect to mention the Prophecy of *Daniel* of the last days of the World,[1] *Many shall run to and fro and knowledge shall be increased*, thus plainly hinting and suggesting that Fate (which is Providence) would cause the complete circuit of the Globe (now accomplished or at least going forward by means of so many distant voyages) and the increase of Learning, to happen at the same epoch.

xciv. [2] We will next give a most potent reason for hope deduced from the errors of the past, and the ways still unattempted. For well was an ill governed State thus reproved,[3] *That which is worst with regard to the past should appear most consolatory for the future. For if you had done all that was duly commanded, and your affairs proceeded no better, you would not even hope for their improvement ; but since their present unhappy situation is not owing to the force of circumstances but to your own errors, you have reason to hope, that*

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[1] Daniel, c. xii, ver. 4.

[2] Hence to Aphorism cviii treats of the Grounds of Hope to be derived from correcting former errors.

[3] See Demosthenes' 3rd Philippic, near the beginning : τὸ χείριστον ἐκ τοῦ παρεληλυθότος, τοῦτο πρὸς τὰ μέλλοντα βέλτιστον ὑπάρχει. Τί οὖν ἐστι τοῦτο; ὅτι οὔτε μικρὸν οὔτε μέγα οὐδὲν τῶν δεόντων ποιούντων ὑμῶν κακῶς τὰ πράγματα ἔχει· ἐπεί τοι εἰ πάνθ' ἃ προσῆκε πραττόντων οὕτως εἶχεν, οὐδ' ἂν ἐλπὶς ἦν αὐτὰ γενέσθαι βελτίω, νῦν δὲ τῆς μὲν ῥᾳθυμίας τῆς ὑμετέρας καὶ τῆς ἀμελείας κεκράτηκε Φίλιππος, τῆς πόλεως δ' οὐ κεκράτηκεν.

by banishing or correcting the latter you can produce a great change for the better in the former. So if men had, during the many years that have elapsed, adhered to the right way of discovering and cultivating the Sciences without being able to advance, it would be assuredly bold and presumptuous to imagine it possible to improve; but if they have mistaken the way and wasted their labour on improper objects, it follows that the difficulty does not arise from Things themselves, which are not in our power, but from the human Understanding, its practice and application, which is susceptible of remedy and correction. Our best plan therefore is to expose these errors. For in proportion as they impeded the past, so do they afford reason to hope for the future. And although we have touched upon them above, yet we think it right to give a brief, bare, and simple enumeration of them in this place.

xcv. Those who have treated of the Sciences have been either Empirics or Dogmatical. The former like ants only heap up and use their store, the latter like spiders spin out their own webs. The bee, a mean between both, extracts matter from the flowers of the garden and the field, but works and fashions it by its own efforts. The true labour of Philosophy resembles hers, for it neither relies entirely or principally on the powers of the Mind, nor yet lays up in the Memory the matter afforded by the Experiments of Natural History or Mechanics in its raw state, but changes and works it in the Understanding. We have good reason therefore to derive hope from a closer and purer alliance of these faculties (the Experimental and Rational) than has yet been attempted.

xcvi. Natural Philosophy is not yet to be found unadulterated, but is impure and corrupted; by Logic in the school of *Aristotle*, by natural Theology in that of *Plato*, by Mathematics in the second school of *Plato* (that of Proclus and others) *which* ought rather to terminate natural Philosophy than to generate or create it. We may therefore hope for better results from pure and unmixed natural Philosophy.

xcvii. No one has yet been found possessed of sufficient firmness and severity to resolve upon and undertake the task of entirely abolishing common Theories and Notions, and applying the Mind afresh, when thus cleared and levelled, to particular researches. Hence our human Reasoning is a mere farrago and crude mass made up of a great deal of credulity and accident, and the puerile Notions it originally contracted.

But if a man of mature age, unprejudiced senses, and clear mind, would betake himself anew to Experience and Particulars, we might hope much more from such a one. In which respect we promise ourselves the fortune of *Alexander* the Great, and let none accuse us of vanity till they have heard the tale, which is intended to check vanity.

For *Æschines* spoke thus of *Alexander* and his exploits : *We live not the life of mortals, but are born at such a period that posterity will relate and declare our prodigies.* As if he considered the exploits of *Alexander* to be miraculous.

But in succeeding ages [1] *Livy* took a better view of the fact, and has made some such observation as this upon *Alexander : That he did no more than dare to despise insignificance.* So in our opinion posterity will judge of us, *That we have achieved no great matters, but only set less account upon what is considered important.* For the mean time (as we have before observed) our only hope is in the *Regeneration* of the Sciences, by regularly raising them on the foundation of Experience and building them anew, which I think none can venture to affirm to have been already done or even thought of.

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[1] See *Livy*, lib. ix. c. 17, where in a digression on the probable effect of a contest between *Rome* and *Alexander* the Great he says : 'Non cum *Dario* rem esse dixisset : quem mulierum ac spadonum agmen trahentem inter purpuram atque aurum, oneratum fortunæ apparatibus, prædam veriùs quam hostem, *nihil aliud quam ausus vana contemnere, incruentus devicit.*'

xcviii. The foundations of Experience (our sole resource) have hitherto failed completely or have been very weak; nor has a store and collection of Particular facts capable of informing the Mind or in any way satisfactory, been either sought after or amassed. On the contrary Learned, but idle and indolent, men have received some mere reports of Experience, traditions as it were of dreams, as establishing or confirming their Philosophy; and have not hesitated to allow them the weight of legitimate evidence. So that a system has been pursued in Philosophy with regard to Experience, resembling that of a Kingdom or State which would direct its councils and affairs according to the gossip of City and Street politicians, instead of the letters and reports of Ambassadors and Messengers worthy of credit. Nothing is rightly inquired into, or verified, noted, weighed, or measured, in Natural History. Indefinite and vague observation produces fallacious and uncertain information. If this appear strange or our complaint somewhat too unjust (because *Aristotle* himself, so distinguished a man and supported by the wealth of so great a King, has completed an accurate History of *Animals*, to which others with greater diligence but less noise have made considerable additions, and others again have composed copious histories and notices of Plants, Metals, and Fossils), it will arise from a want of sufficiently attending to and comprehending our present observations. For a Natural History compiled on its own account, and one collected for the Mind's information as a foundation for Philosophy, are two different things. They differ in several respects, but principally in this; the former contains only the varieties of natural species without the Experiments of Mechanical Arts. For as in Ordinary *Life every* person's disposition, and the concealed feelings of the mind and passions, are most drawn out when they are disturbed; so the secrets of Nature betray themselves more readily when tormented by Art, than when left to their own course. We must begin therefore to entertain hopes of Natural Philosophy then only, when we have a better compilation of Natural History, its real basis and support.

xcix. Again even in the abundance of Mechanical Experiments there is a very great scarcity of those which best inform and assist the understanding. For the Mechanic, little solicitous about the investigation of truth, neither directs his attention nor applies his hand to any thing that is not of service to his business. But our Hope of further progress in the Sciences will then only be well founded, when numerous experiments shall be received and collected into Natural History, which though of no use in themselves, assist materially in the discovery of causes and Axioms: which Experiments we have termed *enlightening*, to distinguish them from those which are *Profitable*. They possess this wonderful property and nature that they never deceive or fail you, for being used only to discover the natural cause of some object, whatever be the result, they equally satisfy your aim by deciding the question.

c. We must not only search for and procure a greater number of Experiments, but also introduce a completely different Method, Order, and Progress of continuing and promoting Experience. For vague and arbitrary Experience is (as we have observed) mere groping in the dark, and rather astonishes than instructs. But when Experience shall proceed regularly and uninterruptedly by a determined rule, we may entertain better hopes of the Sciences.

ci. But after having collected and prepared an Abundance and Store of Natural History, and of the Experience required for the operations of the Understanding, or *Philosophy*; still the Understanding is as incapable of acting on such Materials of itself with the aid of memory alone, as any person would be of retaining and achieving by memory the Computation of an Almanack. Yet Meditation has hitherto done more for discovery than Writing, and no Experiments have been committed to paper. We cannot however approve of any mode of discovery without Writing, and when that comes into more general use we may have further hopes.

cii. Besides this there is such a multitude and host as it were of particular objects, and lying so widely dispersed, as to distract and confuse the Understanding; and we can therefore hope for no advantage from its skirmishing, and quick Movements and incursions, unless we put its forces in due order and array by means of proper, and well arranged, and as it were living tables of discovery of these matters which are the subject of investigation, and the Mind then apply itself to the ready prepared and digested aid which such tables afford.

ciii. When we have thus properly and regularly placed before the eyes a Collection of particulars, we must not immediately proceed to the Investigation and discovery of new particulars or effects, or, at least if we do so, must not rest satisfied therewith. For, though we do not deny that by transferring the Experiments from one Art to another (when all the Experiments of each have been collected and arranged, and have been acquired by the knowledge and subjected to the judgment of a single individual) many new Experiments may be discovered tending to benefit society and mankind, by what we term Literate Experience; yet comparatively insignificant results are to be expected thence, whilst the More Important are to be derived from the new light of Axioms, deduced by certain method and rule from the above particulars, and pointing out and defining new particulars in their turn. Our road is not along a plain, but rises and falls, Ascending to Axioms and Descending to Effects.

civ. Nor can we suffer the Understanding to jump and fly from particulars to remote and most general Axioms (such as are termed the Principles of Arts and Things), and thus prove and make out their intermediate Axioms according to the supposed unshaken truth of the former. This, however, has always been done to the present time from the natural bent of the Understanding, educated to and accustomed to this very method by the Syllogistic mode of Demonstration. But we can then only augur well for the Sciences, when the ascent shall proceed by a true Scale and successive steps, without interruption or breach, from particulars to the lesser Axioms, thence to the intermediate (rising one above the other), and lastly to the most general. For the lowest Axioms differ but little from bare Experiment, the highest and most general (as they are esteemed at present) are notional, abstract and of no real weight. The Intermediate are true, solid, full of life, and upon them depend the business and fortune of mankind ; beyond these are the really general, but not abstract, axioms, which are truly limited by the intermediate.

We must not then add wings but rather lead and ballast to the Understanding, to prevent its jumping or flying, which has not yet been done ; but whenever this takes place we may entertain greater hopes of the Sciences.

cv. In forming Axioms, we must invent a different form of *Induction* from that hitherto in use ; not only for the proof and discovery of principles (as they are called), but also of minor intermediate, and in short every kind of Axioms. The Induction which proceeds by simple enumeration is puerile, leads to uncertain conclusions, and is exposed to danger from one contradictory instance, deciding generally from too small a number of facts, and those only *the most obvious.* But a really useful *Induction* for the discovery and demonstration of the Arts and Sciences should separate Nature by proper rejections and exclusions, and then conclude for the affirmative after collecting a sufficient number of negatives. Now this has not been done, or even attempted, except perhaps by *Plato*, who certainly uses this form of Induction in some measure, to sift definitions and ideas. But much of what has never yet entered the thoughts of man, must necessarily be employed in order to exhibit a good and legitimate mode of Induction, or Demonstration; so as even to render it essential for us to bestow more pains upon it than have hitherto been bestowed on Syllogisms. The assistance of Induction is to serve us not only in the discovery of Axioms, but also in defining our Notions. Much indeed is to be hoped from such an *Induction* as has been described.

cvi. In forming our Axioms from Induction, we must examine and try, whether the Axiom we derive be only fitted and calculated for the particular instances from which it is deduced, or whether it be more extensive and general. If it be the latter, we must observe, whether it confirm its own extent and generality by giving surety as it were, in pointing out new particulars, so that we may neither stop at actual discoveries, nor with a careless grasp catch at shadows and abstract forms, instead of substances of a determinate nature: and as soon as we act thus, well-authorised hopes may with reason be said to beam upon us.

cvii. Here, too, we may again repeat what we have said above, concerning the extending of Natural Philosophy and reducing particular Sciences to that one, so as to prevent any schism or dismembering of the Sciences; without which we cannot hope to advance.

cviii. Such are the observations we would make in order to remove despair and excite hope, by bidding farewell to the errors of *past* ages or by their correction. Let us *examine whether* there be other grounds for hope. And, first, if many useful discoveries have occurred to mankind by chance or opportunity, without investigation or attention on their part, it must necessarily be acknowledged that much more may be brought to light by investigation and attention, if it be regular and orderly, not hasty and interrupted. For although it may now and then happen that one falls by chance upon something that had before escaped considerable efforts and laborious inquiries, yet undoubtedly the reverse is generally the case. We may, therefore, hope for further, better, and more frequent results from man's reason, industry, method, and application, than from chance and mere animal instinct, and the like, which have hitherto been the sources of Invention.

cix. We may also derive some reason for hope from the circumstance of several actual inventions being of such a nature, that scarcely any one could have formed a conjecture about them previously to their discovery, but would rather have ridiculed them as impossible. For men are wont to guess about new subjects from those they are already acquainted with, and the hasty and vitiated fancies they have thence formed: than which there cannot be a more fallacious mode of reasoning, because much of that which is derived from the sources of things does not flow in their usual channel.

If, for instance, before the discovery of cannon, one had described its effects in the following manner: There is a new Invention, by which walls and the greatest bulwarks can be shaken and overthrown from a considerable distance; men would have begun to contrive various means of multiplying the force of projectiles and machines by means of weights and wheels, and other modes of battering and projecting. But it is improbable that any imagination or fancy would have hit upon a fiery blast expanding and developing *itself so* suddenly and violently, because none would have *seen an instance* at all resembling it, except perhaps in earthquakes or thunder, which they would have immediately rejected as the Great Operations of Nature, not to be imitated by man.

So, if before the discovery of silk thread any one had observed, That a species of thread had been Discovered fit for dresses and furniture, far surpassing the thread of worsted or flax in fineness, and at the same time in tenacity, beauty, and softness ; men would have begun to imagine something about Chinese plants, or the fine hair of some animals, or the feathers or down of birds, but certainly would never have had an idea of its being spun by a small worm, in so copious a manner, and renewed annually. But if any one had ventured to suggest the silk worm, he would have been laughed at as if dreaming of some new manufacture from spiders.

So again, if before the discovery of the Compass any one had said, That an instrument had been Invented, by which the Quarters and points of the Heavens could be exactly taken and distinguished ; men would have entered into disquisitions on the refinement of Astronomical instruments, and the like, from the excitement of their imaginations ; but the thought of any thing being discovered, which not being a celestial body, but a mere mineral or metallic substance, should yet in its motion agree with that of such bodies, would have appeared absolutely incredible. Yet were these facts, and the like (unknown for so many ages) not discovered at last either by Philosophy or Reasoning, but by chance and opportunity ; and (as we have observed) they are of a nature most heterogeneous, and remote from what was hitherto known, so that no previous knowledge could lead to them. We may, therefore, well hope[1] that many excellent and useful matters are yet treasured up in the bosom of Nature, bearing no relation or analogy to our actual Discoveries, but out of the common track of our imagination, and still undiscovered; and which will doubtless be brought to light in the course and lapse of years, as the others have been before them; but in the way we now point out, they may rapidly and at once be both represented and anticipated.

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[1] This hope has been abundantly realised in the discovery of Gravity and the decomposition of Light, strictly by the Inductive *Method. To a better* Philosophy we may also attribute the discovery

cx. There are moreover some Inventions which render it probable that men may pass and hurry over the most noble Discoveries which lie immediately before them. For however the discovery of Gunpowder, silk, the Compass, Sugar, Paper, or the like, may appear to depend on peculiar properties of things and Nature, Printing at least involves no contrivance which is not clear and almost obvious. But from want of observing that although the arrangement of the types of letters required more trouble than Writing with the hand, yet these types once arranged serve for innumerable impressions whilst manuscript only affords one copy; and again, from want of observing that ink might be thickened so as to stain without running (which was necessary, seeing the letters face upwards, and the impression is made from above), this most beautiful Invention (which assists so materially the propagation of Learning) remained unknown for so many ages.

The human Mind is often so awkward and ill regulated in the career of Invention, that it is at first diffident, and then despises itself. For it appears at first incredible that any such discovery should be made, and when it has been made, it appears incredible that it should so long have escaped men's research.—All which affords good reason for the hope that a vast mass of Inventions yet remains,

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of Electricity, Galvanism, and their mutual connection with each other, and Magnetism, the Inventions of the Air Pump, Steam Engine, Chronometer, &c.

which may be deduced not only from the investigation of new modes of operation, but also from transferring, comparing, and applying these already known, by the method of what we have termed Literate Experience.

cxi. Nor should we omit another ground of Hope. Let men only consider (if they will) their infinite expenditure of talent, time, and fortune, in matters and studies of far inferior importance and value: a small portion of which applied to sound and solid learning would be sufficient to overcome every difficulty. And we have thought right to add this observation, because we candidly own that such a collection of Natural and Experimental History as we have traced in our own mind, and as is really necessary, is a great and as it were Royal work, requiring much labour and expense.

cxii. In the meantime let no one be alarmed at the multitude of particulars, but rather inclined to hope on that very account. For the particular *Phenomena* of the Arts and Nature are in reality but as a Handful, when compared with the fictions of the Imagination removed and separated from the evidence of facts. The termination of our method is clear, and I had almost said, near at hand; the other admits of no termination but only of infinite confusion. For Men have hitherto dwelt but little, or rather only slightly touched upon Experience, whilst they have wasted much time on theories and the fictions of the imagination. If we had but any one who could actually answer our interrogations of Nature, the Invention of all Causes and Sciences would be the labour of but a few years.

cxiii. We think some ground of hope is afforded by our own example, which is not mentioned for the sake of boasting, but as a useful remark. Let those who distrust their own powers observe myself, one who have amongst my contemporaries been the most engaged in Public business, who am not very strong in health (which causes a great loss of time), and am the *First Explorer* of this course, following the guidance of none, nor even communicating my thoughts to a single individual; yet having once firmly entered in the right way, and submitting the powers of my mind to things, I have somewhat advanced (as I make bold to think) the matter I now treat of. Then let others consider what may be hoped from men who enjoy abundant leisure, from united labours, and the succession of ages, after these suggestions on our part, especially in a course which is not confined, like theories, to individuals, but admits of the best distribution and union of labour and effect, particularly in Collecting Experiments. For men will then only begin to know their own power, when each performs a separate part, instead of undertaking in crowds the same work.

cxiv. Lastly, though a much more faint and uncertain breeze of Hope were to spring up from *our new Continent*, yet we consider it necessary to make the experiment, if we would not show a dastard spirit. For the risk attending want of success is not to be compared with that of neglecting the attempt; the former is attended with the loss of a little human labour, the latter with that of an immense benefit. For these and other reasons it appears to us that there is abundant ground to hope, and to induce not only those who are sanguine to make experiment, but even those who are cautious and sober to give their assent.

cxv. Such are the grounds for banishing despair, hitherto one of the most powerful Causes of the delay and restraint to which the Sciences have been subjected; in treating of which, we have at the same time discussed the Signs and Causes of the Errors, idleness, and ignorance, that have prevailed: seeing especially that the more refined causes, which are not open to popular judgment and observation, may be referred to our remarks on the *Idols* of the human mind.

Here too we should close the demolishing branch of our *Instauration*, which is comprised in three Confutations. 1. The Confutation of *Natural Human Reason* left to itself. 2. The Confutation of *Demonstration*. 3. The Confutation of *Theoriès*, or received systems of Philosophy and Doctrines. Our Confutation has followed such a course as was open to it, namely, the exposing of the signs of error, and the producing Evidence of the Causes of it: for we could adopt no other, differing as we do both in first Principles and Demonstrations from others.

It is time for us therefore to come to the Art itself, and the Rule for the *Interpretation of Nature*: there is however still something which must not be passed over. For the intent of this first book of *Aphorisms* being to prepare the Mind for understanding, as well as admitting, what follows, we must now, after having Cleansed, polished, and levelled its Surface, place it in a good position, and as it were a benevolent Aspect towards our propositions; seeing that prejudice in new matters may be produced not only by the strength of pre-conceived notions, but also by a false anticipation or expectation of the matter proposed. We shall therefore endeavour to induce good and correct opinions of what we offer, although this be only necessary for the moment, and as it were laid out at interest, until the matter itself be well understood.

cxvi. First then, we must desire men not to suppose that we are ambitious of founding any Philosophical sect, like the Ancient Greeks, or some moderns, as *Telesius*,[1] *Patricius*,[2] and *Severinus*.[1] For neither is this our intention, nor do we think that peculiar abstract opinions on Nature and the Principles of things, are of much importance to men's fortunes ; since it were easy to revive many ancient theories, and to introduce many new ones ; as for instance, many Hypotheses with regard to the Heavens can be formed, differing in themselves, and yet sufficiently according with the *Phenomena*.

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[1] *Bernardino Telesio*, a *Neapolitan*. He studied at *Padua*, and published his *De Rerum Naturâ juxta propria Principia* in 1565, in opposition to *Aristotle*. He applied Mathematics to Physics, and held some notions similar to those of *Parmenides*.

[2] *Francesco Patrizio*, born in *Cherso*, on the coast of *Dalmatia*, in 1529. He studied at *Padua*, and was afterwards professor of Platonic Philosophy at *Rome* till his death in 1597. He impugned *Aristotle's Philosophy* in his *Nova de Universis Philosobhia*.

We bestow not our labour on such theoretical and, at the same time, useless topics. On the contrary, our determination is that of trying, whether we can lay a firmer foundation, and extend to a greater distance the boundaries of human power and dignity. And although, here and there, upon some particular points, we hold (in our own opinion) more true and certain, and I might even say, more advantageous tenets, than those in general repute (which we have collected in the fifth part of our *Instauration*), yet we offer no universal or complete Theory. The time does not yet appear to us to be arrived, and we entertain no hope of our life being prolonged to the completion of the sixth part of the *Instauration* (which is destined for Philosophy discovered by the interpretation of Nature), but are content if we proceed quietly and usefully in our Intermediate Pursuit, scattering, in the mean time, the seeds of less adulterated truth for posterity, and, at least, commence the great work.

cxvii. And, as we pretend not to Found a Sect, so do we neither Offer nor Promise particular effects : which may occasion some to object to us, that since we so often speak of Effects, and consider every thing in its relation to that end, we ought also to give some earnest of producing them. Our course and method however (as we have often said, and again repeat) is such as not to deduce Effects from Effects, nor Experiments from Experiments (as the Empirics do), but in our capacity of legitimate Interpreters of Nature to deduce Causes and Axioms from Effects and Experiments; and new Effects and Experiments from those Causes and Axioms.

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[1] *Marco Aurelio Severini*, a learned physician of *Naples*, who published an attack on *Aristotle's* Natural History, and several other Works. He was born in 1580.

And although any one of moderate intelligence and ability will observe the indications and sketches of many noble effects in our Tables of inventions (which form the fourth part of the *Instauration*), and also in the examples of particular instances cited in the second part, as well as in our observations on History (which is the Subject of the third part); yet we candidly confess that our present Natural History, whether compiled from books, or our own inquiries, is not sufficiently copious and well ascertained to satisfy or even assist a proper Interpretation.

If, therefore, there be any one who is more disposed and prepared for Mechanical Art, and ingenious in discovering effects, than in the mere management of Experiment, we allow him to employ his industry in gathering many of the fruits of our History and Tables in his way, and applying them to Effects, receiving them as interest till he can obtain the principal. For our own part, having a greater object in view, we condemn all hasty and premature rest in such pursuits, as we would Atalanta's apple (to use a common allusion of ours); for we are not childishly ambitious of golden fruit, but use all our efforts to make the course of Art outstrip Nature, and we hasten not to reap moss or the green blade, but wait for a ripe harvest.

cxviii. There will be some, without doubt, who, on a perusal of our History and Tables of Invention, will meet with some uncertainty, or perhaps fallacy, in the Experiments themselves, and will thence perhaps imagine that our Discoveries are built on false foundations and Principles. There is, however, really nothing in this, since it must needs happen in beginnings. For it is the same as if in writing or printing one or two letters were wrongly turned or misplaced, which is no great inconvenience to the reader, who can easily by his own eye correct the error; let men in the same way conclude that many Experiments in Natural History may be erroneously believed and admitted, which are easily expunged and rejected afterwards by the Discovery of Causes and Axioms. It is, however, true that if these errors in Natural History and Experiments become great, frequent, and continued, they cannot be corrected and amended by any dexterity of wit or Art. If then, even in our Natural History, well examined and compiled with such diligence, strictness, and (I might say) reverential scruples, there be now and then something false and erroneous in the details, what must we say of the common Natural History, which is so negligent and careless when compared with ours? or of systems of Philosophy and the Sciences based on such loose soil (or rather Quicksand)? Let none then be alarmed by such observations.

cxix. Again our History and Experiments will contain much that is light and common, mean and illiberal, too refined and merely speculative, and as it were of no use, and this perhaps may divert and alienate the attention of mankind.

With regard to what is common; let men reflect, that they have hitherto been used to do nothing but refer and adapt the causes of things of rare occurrence to those of things which more frequently happen without any investigation of the causes of the latter, taking them for granted and admitted.

Hence they do not inquire into the causes of Gravity, the Rotation of the Heavenly Bodies, Heat, Cold, Light, Hardness, Softness, Rarity, Density, Liquidity, Solidity, *Animation*, Inanimation, Similitude, Difference, Organic *Formation*, *but* taking them to be self-evident, manifest, and admitted, they dispute and decide upon other matters of less frequent and familiar occurrence.

But we (who know that no judgment can be formed of that which is rare or remarkable, and much less any thing new brought to light, without a previous regular examination and discovery of the causes of that which is common, and the causes again of those causes) are necessarily compelled to admit the most common objects into our History. Besides, we have observed that nothing has been so injurious to Philosophy as this circumstance, namely, that familiar and frequent objects do not arrest and detain men's contemplation, but are carelessly admitted, and their causes never inquired after; so that Information on unknown subjects is not more often wanted than Attention to those which are known.

cxx. With regard to the Meanness or even the Filthiness of particulars, for which (as *Pliny* observes) an apology is requisite, such subjects are no less worthy of admission into Natural History than the most magnificent and costly: nor do they at all pollute Natural History, for the Sun enters alike the palace and the privy, and is not thereby polluted. We neither dedicate nor raise a Capitol or Pyramid to the pride of man, but rear a holy Temple in his mind, on the model of the Universe, which model therefore we imitate. For that which is deserving of Existence is deserving of Knowledge, the image of existence. Now the mean and splendid alike exist. Nay, as the finest odours are sometimes produced from putrid matter (such as Musk and Civet), so does valuable light and information emanate from mean and sordid instances. But we have already said too much, for such fastidious feelings are childish and effeminate.

cxxi. The next point requires a more accurate consideration, namely, that many parts of our History will appear to the vulgar, or even any mind accustomed to the *present state of* things, fantastically and uselessly refined.

Hence we have in regard to this matter said from the first, and must again repeat, that we look for Experiments that shall afford *light* rather than *profit*, imitating the divine Creation, which, as we have often observed, only produced light on the first day, and assigned that whole day to its creation, without adding any material work.

If any one then imagine such matters to be of no use, he might equally suppose Light to be of no use, because it is neither solid nor material. For in fact the knowledge of Simple Nature when sufficiently investigated and defined resembles Light, which though of no great use in itself, affords access to the general mysteries of Effects, and with a peculiar power comprehends and draws with it whole bands and troops of Effects and the sources of the most valuable Axioms. So also the elements of Letters have of themselves separately no meaning, and are of no use, yet are they as it were the original Matter in the composition and preparation of speech. The seeds of substances whose effect is powerful, are of no use except in their growth, and the scattered rays of light itself avail not unless collected.

But if speculative Subtilties give offence, what must we say of the Scholastic Philosophers who indulged in them to such excess? And those Subtilties were wasted on words, or at least common notions (which is the same thing), not on things or Nature, and alike unproductive of benefit in their Origin and their Consequences: in no way resembling ours, which are at present useless, but in their consequences of infinite benefit. Let men be assured that all Subtle disputes and discursive efforts of the Mind are late and preposterous, when they are introduced subsequently to the discovery of Axioms, and that their true or at any rate chief Opportunity is when Experiment is to be weighed and Axioms to be derived from it. They otherwise catch and grasp at Nature, but never seize or detain her: and we may well apply to Nature that which has been said of Opportunity or Fortune, *that she wears a lock in front, but is bald behind.*

In short we may reply decisively to those who despise any part of Natural History as being Vulgar, Mean, or Subtile and useless in its origin, in the words of a Poor Woman to a haughty Prince who had rejected her petition, as unworthy and beneath the dignity of his Majesty: *Then cease to reign*; for it is quite certain that the empire of Nature can neither be obtained nor administered by one who refuses to pay attention to such matters as being poor and too minute.

cxxii. Again it may be objected to us as being singular and harsh, that we should with one stroke and assault, as it were, banish all Authorities and Sciences, and that too by our own efforts, without requiring the assistance and support of any of the Ancients.

Now we are aware, that had we been ready to act otherwise than sincerely, it was not difficult to refer our present method to remote ages prior to those of the *Greeks* (since the Sciences in all probability flourished more in their Natural state, though silently, than when they were paraded with the fifes and trumpets of the *Greeks*); or even (in parts at least) to some of the *Greeks* themselves, and to derive authority and honour from thence; as men of no family labour to raise and form nobility for themselves in some ancient line, by the help of genealogies. Trusting however to the evidence of facts, we reject every kind of fiction and imposture: and think it of no more consequence to our subject, whether future discoveries were known to the Ancients, and set or rose according to the vicissitudes of events and lapse of ages, than it would be of importance to mankind to know whether the New World be the Island of *Atlantis*,[1] and known to the Ancients, or be now discovered for the first time.

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[1] See *Plato's* Timæus.

With regard to the universal censure we have bestowed, it is quite clear to any one who properly considers the matter, that it is both more probable and more modest than any partial one could have been. For if the errors had not been rooted in the primary Notions, some well conducted discoveries must have corrected others that were deficient. But since the errors were fundamental, and of such a nature that men may be said rather to have neglected or passed over things than to have formed a wrong or false judgment of them, it is little to be wondered at, that they did not obtain what they never aimed at, nor arrive at a goal which they had not determined, nor perform a course which they had neither entered upon nor adhered to.

With regard to our presumption, we allow that if we were to assume a power of drawing a more perfect straight line or circle than any one else by superior steadiness of hand or acuteness of eye, it would lead to a comparison of talent; but if one merely assert that he can draw a more perfect line or circle with a ruler or compasses, than another can by his unassisted hand or eye, he surely cannot be said to boast of much. Now this applies not only to our first original attempt, but also to those who shall hereafter apply themselves to the pursuit. For our method of Discovering the Sciences merely levels men's wits and leaves but little to their superiority, since it achieves everything by the most certain Rules and Demonstrations. Whence (as we have often observed) our attempt is to be attributed to Fortune rather than Talent, and is the offspring of Time rather than of Wit. For a certain sort of Chance has no less effect upon our Thoughts than on our Acts and Deeds.

cxxiii. We may therefore apply to ourselves the joke of him who said *that water and wine drinkers could not think alike*, especially as it hits the matter so well. For others, both Ancients and Moderns, have in the Sciences drank a crude liquor like water, either flowing of itself from the

Understanding or drawn up by Logic as the wheel draws up the bucket. But we drink and pledge others with a liquor made of many well ripened grapes collected and plucked from particular branches, squeezed in the press, and at last clarified and fermented in a vessel. It is not therefore wonderful that we should not agree with others.

cxxiv. Another objection will without doubt be made, namely, that we have not ourselves established a correct or the best Goal or Aim of the Sciences (the very defect we blame in others). For they will say that the Contemplation of truth is more dignified and exalted than any utility or extent of Effects: but that our dwelling so long and anxiously on Experience and Matter, and the fluctuating state of Particulars fastens the Mind to earth, or rather casts it down into an Abyss of confusion and disturbance, and separates and removes it from a much more divine state, the quiet and tranquillity of Abstract Wisdom. We willingly assent to their reasoning, and are most anxious to effect the very point they hint at and require. For we are founding a real model of the World in the Understanding, such as it is found to be, not such as man's reason has distorted. Now this cannot be done without dissecting and Anatomising the World most diligently; but we declare it necessary to destroy completely the vain little, and as it were apish imitations of the World, which have been formed in various systems of Philosophy by men's fancies. Let men learn (as we have said above) the difference that exists between the *Idols* of the human Mind and the Ideas of the divine Mind. The former are mere arbitrary Abstractions; the latter the true marks of the Creator on his creatures, as they are imprinted on, and defined in Matter, by true and exquisite touches. Truth, therefore, and Utility are here perfectly Identical, and the Effects are of more value as pledges of truth than from the benefit they confer on men.

cxxv. Others may object that we are only doing that which has already been done, and that the Ancients followed the same course as ourselves. They may imagine, therefore, that, after all this stir and exertion, we shall at last arrive at some of those Systems that prevailed among the Ancients: for that they too, when commencing their Meditations, laid up a great store of Instances and Particulars, and digested them under topics and titles in their Common Place-Books, and so worked out their Systems and Arts, and then decided upon what they discovered, and related now and then some Examples to confirm and throw light upon their doctrine; but thought it superfluous and troublesome to publish their notes, minutes, and common-places, and therefore followed the example of builders who remove the scaffolding and ladders when the building is finished. Nor can we indeed believe the case to have been otherwise. But to any one, not entirely forgetful of our previous observations, it will be easy to answer this objection or rather scruple. For we allow that the Ancients had a particular form of investigation and discovery, and their writings show it. But it was of such a nature, that they immediately flew from a few Instances and Particulars (after adding some common Notions, and a few generally received opinions most in vogue) to the most general Conclusions or the Principles of the Sciences, and then by their intermediate propositions deduced their inferior Conclusions, and tried them by the test of the immoveable and settled truth of the first, and so constructed their Art. Lastly, if some new Particulars and Instances were brought forward, which contradicted their dogmas, they either with great subtilty reduced them to one system, by distinctions or explanations of their own rules, or got rid of them clumsily as exceptions, labouring most pertinaciously in the mean time to accommodate the causes of such as were not contradictory to their own Principles. *Their Natural* History and their Experience were both far from being what they ought to have been, and their flying off to Generalities ruined every thing.

cxxvi. Another objection will be made against us, that we prohibit decisions, and the laying down of certain principles, till we arrive regularly at Generalities by the intermediate steps, and thus keep the judgment in Suspense and lead to uncertainty. But our object is not uncertainty but fitting certainty, for we derogate not from the Senses but assist them, and despise not the Understanding but direct it. It is better to know what is necessary, and not to imagine we are fully in possession of it, than to imagine that we are fully in possession of it, and yet in reality to know nothing which we ought.

cxxvii. Again, some may raise this question rather than objection, whether we talk of perfecting Natural Philosophy alone according to our method, or the other Sciences also, such as Logic, Ethics, Politics. We certainly intend to comprehend them all. And as common Logic, which regulates matters by Syllogisms, is applied not only to Natural but also to every other Science, so our *Inductive Method* likewise comprehends them all. For we form a History and Tables of invention for Anger, Fear, Shame, and the like, and also for examples in Civil life, and the mental operations of Memory, Composition, Division, Judgment, and the rest, as well as for Heat and Cold, Light, Vegetation, and the like. But since our method of *Interpretation*, after preparing and arranging a History, does not content itself with examining the operations and disquisitions of the Mind like common Logic; but also inspects the Nature of Things, we so regulate the Mind that it may be enabled to apply itself in every respect correctly to that nature. On that account we deliver numerous and various precepts in our Doctrine of *Interpretation*, so that they may apply in some measure to the method of discovering the quality and condition of the Subject matter of investigation.

cxxviii. Let none even doubt whether we are anxious to destroy and demolish the Philosophy, Arts, and Sciences, which are now in use. On the contrary, we readily cherish their practice, cultivation, and honour. For we by no means interfere to prevent the prevalent system from encouraging discussion, adorning Discourses, or being employed serviceably in the chair of the professor or the practice of Common life, and being taken, in short, by general consent as current coin. Nay, we plainly declare, that the system we offer will not be very suitable for such purposes, not being easily adapted to vulgar apprehensions, except by effects and Works. To show our sincerity in professing our regard and friendly disposition towards the received Sciences, we can refer to the evidence of our published Writings (especially our books on the *Advancement of Learning*). We will not, therefore, endeavour to evince it any further by words; but content ourselves with steadily and professedly premising, that no great progress can be made by the present methods in the theory or contemplation of Science, and that they cannot be made to produce any very abundant Effects.

cxxix. It remains for us to say a few words on the excellence of our proposed End. If we had done so before, we might have appeared merely to express our wishes, but now that we have excited hope and removed prejudices, it will perhaps have greater weight. Had we performed and completely accomplished the whole, without frequently calling in others to assist in our labours, we should then have refrained from saying any more, lest we should be thought to extol our own deserts. Since, however, the industry of others must be quickened, and their courage roused and inflamed, it is right to recall some points to their memory.

First then the introduction of great Inventions appears one of the most distinguished of human Actions; and the ancients so considered it. For they assigned divine honours to the authors of Inventions, but only heroic honours to those who displayed Civil merit (such as the Founders of cities and empires, Legislators, the Deliverers of their Country from lasting misfortunes, the Quellers of Tyrants, and the like). And if any one rightly compare them he will find the judgment of antiquity to be correct. For the benefits derived from Inventions may extend to mankind in general, but Civil benefits to particular spots alone; the latter, moreover, last but for a time, the former for ever. Civil reformation seldom is carried on without violence and confusion, whilst Inventions are a blessing and a benefit without injuring or afflicting any.

Inventions are also, as it were, new Creations and Imitations of divine Works; as was expressed by the poet:[1]

> *Primum frugiferos fœtus mortalibus ægris*
> *Dididerant quondam præstanti nomine Athenæ*
> *Et* RECREAVERUNT *vitam legesque rogarunt.*

And it is worthy of remark in *Solomon*, that whilst he flourished in the possession of his Empire, in Wealth, in the magnificence of his Works, in his Court, his Household, his Fleet, the splendour of his Name, and the most unbounded admiration of mankind, he still placed his glory in none of these, but declared[2] that *it is the Glory of God to conceal a thing, but the glory of a King to search it out.*

Again, let any one but consider the immense difference between men's lives in the most polished Countries of Europe, and in any wild and barbarous Region of the New Indies, he will think it so great, that *Man may be said to be a God unto man*, not only on account of mutual aid and benefits, but from their comparative states : the result of the Arts, and not of the Soil or Climate.

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[1] This is the opening of the sixth book of *Lucretius. Bacon* probably quoted from memory; the lines are,

> *Primæ frugiferos fœtus mortalibus ægris*
> *Dididerunt quondam præclaro nomine Athenæ*
> *Et recreaverunt, &c.*
>
> *The teeming corn, that feeble mortals crave,*
> *First, and long since, renowned* Athens *gave,*
> *And cheered their life—then taught to frame their laws.*

[2] *Prov. xxv. 2.*

Again, we should notice the force, effect, and consequences of Inventions, which are nowhere more conspicuous than in those three which were unknown to the Ancients ; namely, *Printing*, *Gunpowder*, and the *Compass*. For these three have changed the appearance and state of the whole World ; first in Literature, then in Warfare, and lastly in Navigation : and innumerable changes have been thence derived, so that no Empire, Sect, or Star, appears to have exercised a greater power and influence on human affairs than these Mechanical discoveries.

It will perhaps be as well to distinguish three species and degrees of Ambition. First that of men who are anxious to enlarge their own power in their Country, which is a vulgar and degenerate kind ; next that of men who strive to enlarge the power and Empire of their Country over mankind, which is more dignified but not less covetous ; but if one were to endeavour to renew and enlarge the power and empire of mankind in general over the Universe, such Ambition (if it may so be termed) is both more sound and more noble than the other two. Now the empire of Man over Things is founded on the Arts and Sciences alone, for Nature is only to be commanded by obeying her.

Besides this, if the benefit of any particular Invention has had such an effect as to induce men to consider him greater than a Man, who has thus obliged the whole race ; how much more exalted will that discovery be, which leads to the easy discovery of every thing else ! Yet (to speak the truth) in the same manner as we are very thankful for light which enables us to enter on our way, to practise Arts, to read, to distinguish each other, and yet sight is more excellent and beautiful than the various uses of light; so is the Contemplation of Things as they are, free from Superstition or Imposture, Error or Confusion, much more dignified in itself than all the advantage to be derived from Discoveries.

Lastly, let none be alarmed at the objection of the Arts and Sciences becoming depraved to malevolent or luxurious purposes and the like, for the same can be said of every worldly Good; Talent, Courage, Strength, Beauty, Riches, Light itself, and the rest. Only let mankind regain their rights over Nature, assigned to them by the gift of God, and obtain that power, whose exercise will be governed by right Reason and true Religion.

cxxx. But it is time for us to lay down the art of *Interpreting* Nature; to which we attribute no absolute necessity (as if nothing could be done without it) nor perfection, although we think that our precepts are most useful and correct. For we are of opinion, that if men had at their command a proper History of Nature and Experience, and would apply themselves steadily to it, and could bind themselves to two things; 1. to lay aside received opinions and notions; 2. to restrain themselves, till the proper season, from generalization, they might, by the proper and genuine exertion of their Minds, fall into our way of *Interpretation* without the aid of any Art. For *Interpretation* is the true and natural act of the Mind, when all obstacles are removed: certainly, however, every thing will be more ready and better fixed by our Precepts.

Yet do we not affirm that no addition can be made to them; on the contrary, considering the Mind in its connexion with Things, and not merely relatively to its own powers, we ought to be persuaded that the Art of Invention can be made *to grow* with the Inventions themselves.

BOOK II

APHORISMS

On the Interpretation of Nature, or the Reign of Man

i. To generate and superinduce a new Nature or new Natures, upon a given Body, is the Labour and Aim of human Power: whilst to discover the Form or true Difference of a given Nature, or the Nature[1] to which such Nature is owing, or Source from which it emanates (for these terms approach nearest to an explanation of our meaning), is the Labour and Discovery of human Knowledge. And subordinate to these primary labours, are two others of a secondary nature and inferior stamp. Under the First must be ranked the transformation of concrete Bodies from one to another, which is *possible* within certain limits; under the Second, the discovery, in every species of generation and Motion, of the *latent* and uninterrupted *process* from the manifest Efficient and manifest Subject Matter up to the given Form: and a like discovery of the *latent Conformation* of Bodies which are at rest instead of being in Motion.

ii. The unhappy state of man's actual Knowledge is manifested even by the common assertions of the vulgar. It is rightly laid down that *true knowledge is that which is deduced from Causes.* The division of four Causes also is *not* amiss: Matter, Form, the Efficient, and End, or Final

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[1] Τὸ τί ἦν εἶναι, or ἡ οὐσία of *Aristotle*. See lib. iii. Metaph.

Cause.[1] Of these, however, the latter is so far from being beneficial, that it even corrupts the Sciences, except in the intercourse of Man with Man. The discovery of Form is considered desperate. As for the Efficient Cause, and Matter (according to the present system of inquiry and the received opinions concerning them, by which they are placed remote from, and without any *latent process* towards, form), they are but desultory and superficial, and of scarcely any avail to real and active Knowledge. Nor are we unmindful of our having pointed out and corrected above the error of the human Mind, in assigning the first qualities of Essence to Forms.[2] For although nothing exists in Nature except individual Bodies, exhibiting clear individual effects according to particular laws :[3] yet in each branch of learning, that very law, its investigation, discovery, and developement, are the foundation both of theory and practice.[4] This *law*, therefore, and its *Parallel in each Science*, is what we understand by the term Form, adopting that word because it has grown into common use, and is of familiar occurrence.

iii. He who has learnt the Cause of a particular Nature, (such as Whiteness of Heat) in particular subjects only, has acquired but an imperfect Knowledge : as he who can induce a certain Effect upon particular Substances only, among those which are susceptible of it, has acquired but an imperfect Power. But he who has only learnt the Efficient and Material Cause (which Causes are variable and mere vehicles conveying Form to particular Substances) may perhaps arrive at some new Discoveries in Matters of a similar nature, and prepared for the purpose, but does not stir the Limits of things which are much more deeply rooted: whilst he who is acquainted with Forms, comprehends the unity of Nature in Substances apparently most distinct from each other. He can disclose and bring forward, therefore (though it has never yet been done) things, which neither the vicissitudes of Nature, nor the industry of Experiment, nor Chance itself, would ever have brought about, and which would for ever have escaped man's thoughts. From the Discovery of Forms, therefore, results genuine Theory and free Practice.

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[1] These divisions are from *Aristotle's* Metaphysics, where they are termed 1. *ὕλη ἢ τὸ ὑποκείμενον.* 2. *τὸ τί ἦν εἶναι.* 3. *ὅθεν ἢ ἀρχὴ τῆς κινήσεως.* 4. *τὸ οὗ ἕνεκεν—καὶ τὸ ἄγαθον.*

[2] See *Aphorism* li. and 2nd paragraph of *Aphorism* lxv. in the first book.

[3] *Plato's ideas* or *forms* are the abstractions or generalizations of distinct species, which have no *real* existence, ***individuals only existing.***

[4] Observe throughout, *Bacon's* term form means no more than law See further 3rd paragraph of *Aphorism* xvii. of this book.

iv. Although there is a most intimate connexion and almost an identity between the ways of human Power and human Knowledge; yet on account of the pernicious and inveterate habit of dwelling upon abstractions, it is by far the safest method to commence and build up the Sciences from those foundations which bear a relation to the Practical division, and to let them mark out and limit the Theoretical. We must consider, therefore, what precepts, or what direction or guide, a person would most desire, in order to generate and superinduce any Nature upon a given Body: and this not in abstruse, but in the plainest language.

For instance, if a person should wish to superinduce the yellow colour of gold upon silver, or an additional weight (observing always the laws of matter) or transparency on an opaque stone, or tenacity in glass, or vegetation on a substance which is not vegetable, we must (I say) consider what species of precept or guide this person would prefer. And firstly, he will doubtless be anxious to be shown some method that will neither fail in effect, nor deceive him in the trial of it. Secondly, he will be anxious that the prescribed method should not restrict him and tie him down to peculiar Means, and certain particular Methods of acting. For he will, perhaps, be at loss, and without the power or opportunity of collecting and procuring such means. Now if there be other Means and Methods (besides those prescribed) of creating such a Nature, they will perhaps be of such a kind as are in his power, yet by the confined limits of the precept he will be deprived of reaping any advantage from them. Thirdly, he will be anxious to be shown something not so difficult as the required effect itself, but approaching more nearly to practice.

We will lay this down, therefore, as the genuine and perfect rule of practice: *that it should be certain, free, and preparatory, or having relation to practice.* And this is the same thing as the Discovery of a true Form. For the Form of any Nature is such, that when it is assigned the particular Nature infallibly follows. It is, therefore, always present when that Nature is present, and universally attests such presence, and is inherent in the whole of it. The same Form is of such a character, that if it be removed the particular Nature infallibly vanishes. It is, therefore, absent, whenever that Nature is absent, and perpetually testifies such absence, and exists in no other Nature. Lastly, the true Form is such, that it deduces the particular Nature from some source of Essence existing in many subjects, and more known (as they term it) to Nature, than the Form itself.[1] Such then is our determination and rule with regard to a genuine and perfect theoretical Axiom; *that a Nature be found convertible with a given Nature, and yet such as to limit the more known Nature, in the manner of a real genus.* But these two rules, the practical and theoretical, are in fact the same, and that which is most useful in Practice is most correct in Theory.

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[1] Thus, to adopt *Bacon's* own illustration, Motion is a property common to many Subjects, from which must be deduced the Form of heat, by defining a particular genus of Motion convertible with heat. See the First Vintage in *Aphorism* xx. below.

v. But the Rule or Axiom for the transformation of Bodies is of two kinds. The first regards the Body as an aggregate or combination of simple Natures. Thus, in Gold are united the following circumstances ; it is yellow, heavy, of a certain weight, malleable and ductile to a certain extent ; it is not volatile, loses part of its substance by fire, melts in a peculiar manner, is separated and dissolved by particular methods, and so of the other Natures observable in Gold. An Axiom, therefore, of this kind deduces the subject from the Forms of simple Natures. For he who has acquired the Forms and Methods of superinducing yellowness, weight, ductility, stability, deliquescence, solution, and the like, and their degrees and modes, will consider and contrive how to unite them in any body, so as to transform [1] it into gold. And this method of operating belongs to primary Action. For it is the same thing to produce one or many simple Natures, except that man is more confined and restricted in his operations, if many be required, on account of the difficulty of uniting many Natures together. It must, however, be observed, that this Method of operating (which considers Natures as simple though in a concrete body) sets out from what is constant, eternal, and Universal in Nature, and opens such broad paths to human power, as the Thoughts of man can in the present state of things scarcely comprehend or figure to itself.

The second kind of Axiom (which depends on the discovery of the *latent process*) does not proceed by simple Natures, but by concrete bodies, as they are found in Nature and in its usual course. For instance ; suppose the Inquiry to be, from what beginnings, in what manner, and by what process Gold or any metal or stone is generated from the original menstruum, or its elements, up to the perfect

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[1] By the recent discoveries in electric Magnetism copper wires, or, *indeed, wires of* any metal may be transformed into Magnets ; the *magnetic law or form* having been to that extent discovered.

Mineral: or in like manner, by what process plants are generated, from the first concretion of juices in the earth, or from seeds, up to the perfect plant, with the whole successive Motion, and varied and uninterrupted efforts of Nature; and the same inquiry be made as to a regularly deduced system of the generation of Animals from Coition to birth, and so on of other bodies.

Nor is this species of Inquiry confined to the mere generation of Bodies, but it is applicable to other changes and labours of Nature. For instance; where an Inquiry is made into the whole series and continued operation of the nutritive process, from the first reception of the food to its complete assimilation to the recipient: or into the voluntary Motion of Animals, from the first impression of the imagination, and the continuous effects of the spirits, up to the bending and motion of the joints; or into the free motion of the tongue and lips, and other accessories which give utterance to articulate sounds. For all these investigations relate to concrete or Associated Natures artificially brought together, and take into consideration certain particular and special habits of Nature, and not those fundamental and general laws which constitute forms. It must, however, be plainly owned, that this method appears more prompt and easy, and of greater promise than the primary one.

In like manner the Operative Branch, which answers to this Contemplative Branch, extends and advances its operation from that which is usually observed in Nature, to other subjects immediately connected with it, or not very remote from such immediate connexion. But the higher and radical operations upon Nature depend entirely on the primary Axioms. Besides, even where man has not the means of acting, but only of acquiring knowledge, as in Astronomy (for man cannot act upon, change, or transform the Heavenly Bodies), the Investigation of facts or truth, as well as the knowledge of Causes and coincidences, must be referred to those primary and Universal Axioms that regard simple Natures; such as the Nature of spontaneous Rotation, Attraction, or the Magnetic force, and many others which are more common than the Heavenly Bodies themselves. For let no one hope to determine the question whether the Earth or Heaven revolve in the diurnal Motion, unless he have first comprehended the Nature of spontaneous Rotation.

vi. But the *Latent Process*, of which we speak, is far from being obvious to men's minds, beset as they now are. For we mean not the measures, symptoms, or degrees of any process which can be exhibited in the bodies themselves, but simply a continued process, which for the most part escapes the observation of the senses.

For instance; in all generations and transformations of Bodies we must inquire, what is in the act of being lost and escaping, what remains, what is being added, what is being diluted, what is being contracted, what is being united, what is being separated, what is continuous, what is broken off, what is urging forward, what impedes, what predominates, what is subservient, and many other circumstances.

Nor are these inquiries again to be made in the mere generation and transformation of Bodies only, but in all other alterations and fluctuations we must in like manner inquire; what precedes, what succeeds, what is quick, what is slow, what produces and what governs Motion, and the like. All which matters are unknown and unattempted by the Sciences, in their present heavy and inactive state. For since every natural Act is brought about by the smallest efforts, or at least such as are too small to strike our senses, let no one hope that he will be able to direct or change Nature unless he have properly comprehended and observed these efforts.

vii. In like manner the Investigation and Discovery of *the latent Conformation* in Bodies is no less new, than the

Discovery of the *latent process* and Form. For we as yet are doubtless only admitted to the antechamber of Nature, and do not prepare an entrance into her presence-room. But nobody can endue a given body with a new Nature, or transform it successfully and appropriately into a new Body, without possessing a complete knowledge of the Body so to be changed or transformed. For he will run into vain or, at least, into difficult and perverse methods, ill adapted to the nature of the body upon which he operates. A clear path, therefore, towards this object also must be thrown open, and well supported.

Labour is well and usefully bestowed upon the Anatomy of Organised Bodies, such as those of men and animals, which appears to be a subtile matter, and an useful examination of Nature. This species of Anatomy, however, is that of first sight, open to the senses, and takes place only in organised bodies. It is obvious, and of ready access, when compared with the real Anatomy of *latent Conformation* in bodies which are considered similar, particularly in specific objects and their parts : as those of iron, stone, and the similar parts of plants and animals, as the root, the leaf, the flower, the flesh, the blood, and bones, &c. Yet human industry has not completely neglected this species of Anatomy : for we have an instance of it in the separation of similar bodies by distillation, and other solutions, which shows the dissimilarity of the compound by the union of the homogeneous parts. These methods are useful, and of importance to our inquiry, although attended generally with fallacy : for many Natures are assigned and attributed to the separate bodies, as if they had previously existed in the compound, which in reality are recently bestowed and superinduced by fire and heat and the other modes of separation. Besides it is, after all, but a small part of the labour of discovering the real *Conformation* in the compound, which is so subtile and nice, that it is rather confused and lost by the operation of the fire, than discovered and brought to light.

* chem-istry

A separation and solution of bodies, therefore, is to be effected, not by fire indeed, but rather by reasoning and true *Induction*, with the assistance of Experiment, and by a comparison with other bodies, and a reduction to those simple Natures and their forms which meet and are combined in the compound; and we must assuredly pass from *Vulcan* to *Minerva*, if we wish to bring to light the real texture and *Conformation* of bodies, upon which every occult and (as it is sometimes called) specific property and virtue of things depends, and whence also every rule of powerful change and transformation is deduced.

For instance, we must examine what spirit is in every body, what tangible essence; whether that Spirit is copious and exuberant, or meagre and scarce, fine or coarse, aeriform or igniform, active or sluggish, weak or robust, progressive or retrograde, abrupt or continuous, agreeing with external and surrounding objects, or differing from them, &c. In like manner must we treat tangible essence (which admits of as many distinctions as the spirit), and its hairs, fibres, and varied texture. Again, the situation of the Spirit in the corporeal mass, its pores, passages, veins, and cells, and the rudiments or first essays of the organic Body are subject to the same Examination. In these, however, as in our former inquiries, and therefore in the whole investigation of *latent Conformation*, the only genuine and clear light which completely dispels all darkness and subtile difficulties, is admitted by means of the primary Axioms.

viii. This method will not bring us to Atoms,[1] which takes for granted the Vacuum, and the immutability of Matter (neither of which hypotheses is correct); but to the real particles such as we discover them to be. Nor is there any ground for alarm at this refinement as if it were inexplicable, for, on the contrary, the more Inquiry is directed to simple Natures, the more will every thing be placed in a plain and perspicuous light; since we transfer our attention from the complicated to the simple, from the incommensurable to the commensurable, from surds to rational quantities, from the indefinite and vague to the definite and certain: as when we arrive at the elements of letters, and the simple tones of concords. The Investigation of Nature is best conducted when Mathematics are applied to Physics. Again, let none be alarmed at vast numbers and fractions; physics for, in calculation, it is as easy to set down or to reflect upon a Thousand as an unit, or the thousandth part of an integer as an integer itself.

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[1] The theory of the *Epicureans* and others. The Atoms are supposed to be indivisible, inalterable Particles, endued with all the properties of the given Body, and forming that Body by their union. They must be separated of course, which either takes a Vacuum for *granted*, or introduces a tertium quid into the composition of the *Body*.

ix.[1] From the two kinds of Axioms above specified arise the two divisions of Philosophy and the sciences, and we will use the commonly adopted terms, which approach the nearest to our meaning, in our own sense. Let the Investigation of *Forms*, which (in reasoning at least, and after their own laws) are eternal and immutable, constitute *Metaphysics*, and let the Investigation of the *Efficient* cause of *Matter*, *latent process*, and *latent Conformation* (which all relate merely to the ordinary course of Nature, and not to her fundamental and eternal laws) constitute *Physics*. Parallel to these let there be two Practical divisions; to *Physics* that of *Mechanics*, and to *Metaphysics* that of *Magic*, in the purest sense of the term, as applied to its ample means and its command over Nature.

x. The object of our philosophy being thus laid down we proceed to precepts, in the most clear and regular order.

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[1] Compare the three following *Aphorisms* with the three last chapters of the third Book of the *De Augmentis Scientiarum*.

The signs for the *Interpretation* of *Nature* comprehend two divisions, the first regards the eliciting or creating of Axioms from Experiment, the second the deducing or deriving of new Experiments from Axioms. The first admits of three subdivisions into Ministrations. 1. To the Senses. 2. To the Memory. 3. To the Mind or Reason.

For we must first prepare as a foundation for the whole a complete and accurate *Natural* and *Experimental History*. We must not imagine or invent, but discover the acts and properties of Nature.

But *Natural* and *Experimental History* is so varied and diffuse, that it confounds and distracts the Understanding unless it be fixed and exhibited in due order. We must, therefore, form *Tables* and *Coordinations* of *Instances*, upon such a plan, and in such order, that the Understanding may be enabled to act upon them.

Even when this is done, the Understanding, left to itself and to its own operation, is incompetent and unfit to construct its Axioms without direction and support. Our third ministration, therefore, must be true and legitimate *Induction*, the very *key* of *Interpretation*. We must begin, however, at the End, and go back again to the others.

xi. The Investigation of Forms proceeds thus : A Nature being given, we must first *present to the Understanding* all the Known *Instances* which agree in the same Nature, although the Subject Matter be considerably diversified. And this collection must be made as a mere history, and without any premature reflection, or too great degree of refinement. For instance : take the Investigation of the Form of Heat.

Instances Agreeing in the Form of Heat

1. The Rays of the Sun, particularly in Summer, and at Noon.

2. The same reflected and condensed, as between mountains, or along walls, and particularly in burning mirrors.

3. Ignited Meteors.

4. Burning Lightning.

5. Eruptions of flames from the Cavities of mountains, &c.

6. Flame of every kind.

7. Ignited solids.

8. Natural Warm Baths.

9. Warm or heated Liquids.

10. Warm Vapours and Smoke, and the Air itself, which admits a most powerful and violent heat if confined, as in Reverberating furnaces.

11. Damp hot Weather, arising from the constitution of the Air, without any reference to the Time of the Year.

12. Confined and subterraneous Air in some Caverns, particularly in winter.

13. All shaggy substances, as wool, the skins of animals, and the plumage of birds, contain some heat.

14. All Bodies, both solid and liquid, dense and rare (as the Air itself), placed near Fire for any time.

15. Sparks arising from the violent percussion of flint and steel.

16. All Bodies rubbed violently, as stone, wood, cloth, &c., so that rudders, and axles of wheels, sometimes catch Fire, and the West Indians obtain fire by Attrition.

17. Green and moist Vegetable Matter confined and rubbed together ; as Roses, peas in baskets ; so hay if it be damp when stacked often catches fire.

18. Quick Lime sprinkled with water.

19. Iron, when first dissolved by acids in a glass, and without any application to fire ; the same of tin, but not so intensely.

20. Animals, particularly internally, although the heat is not perceivable by the touch in insects, on account of their small size.

21. Horse Dung, and the like excrement from other animals when fresh.

22. Strong Oil of Sulphur and of Vitriol exhibit the operation of Heat in burning linen.

23. As does the Oil of Marjoram, and like substances, in burning the bony substance of the teeth.

24. Strong and well-rectified Spirits of wine exhibit the same effects; so that white of eggs when thrown into it grows hard and white, almost in the same manner as when boiled, and bread becomes burnt and brown as if toasted.

25. Aromatic substances and warm plants as the Dracunculus [arum], old Nasturtium, &c.; which though they be not warm to the touch (whether whole or pulverised), yet are discovered by the tongue and palate to be warm and almost burning when slightly masticated.

26. Strong Vinegar and all acids, on any part of the body not clothed with the *Epidermis*, as the eye, tongue, or any wounded part, or where the skin is removed, excite a pain differing but little from that produced by heat.

27. Even a severe and intense cold produces a sensation of burning.[1]

Nec Boreæ penetrabile frigus adurit.

28. Other instances.

We are wont to call this a *Table of Existence and Presence.*

xii. We must next *present* to the Understanding *Instances* which do not admit of the given Nature; for Form (as we have observed) ought no less to be absent where the given Nature is absent, than to be present where it is present. If, however, we were to examine every instance our labour would be infinite.

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[1] 'Ne tenues pluviæ, rapidive potentia solis
Acrior, aut *Boreæ* penetrabile frigus adurat.'
Virg. Georg. i. 92, 93.

Negatives, therefore, must be classed under the *Affirmatives*, and the Want of the given Nature must be inquired into more particularly in Objects which have a very close connexion with those others in which it is present and manifest. And this we are wont to term a *Table* of *deviation* or of *Absence in proximity*.

Proximate Instances wanting the nature of Heat

1st negative subjunctive instance to the 1st affirmative instance.

The rays of the Moon, Stars, and Comets, are not found to be Warm to the touch, nay, the severest cold has been observed to take place at the Full of the Moon. Yet the Larger fixed Stars are supposed to increase and render more intense the heat of the Sun, as he approaches them; when the Sun is in the Sign of the Lion for instance, and in the Dog-Days.

2nd negative to the 2nd affirmative.

The Rays of the Sun in what is called the Middle Region of the Air give no heat, to account for which the commonly assigned reason is satisfactory; namely, that that Region is neither sufficiently near to the Body of the Sun whence the rays emanate, nor to the Earth whence they are reflected. And the fact is manifested by snow being perpetual on the tops of Mountains, unless extremely lofty. But it is observed on the other hand by some, that at the *Peak of Teneriffe*, and also among the *Andes of Peru*, the tops of the Mountains are free from snow, which only lies in the lower part, as you ascend. Besides, the air on the Summit of these Mountains is found to be by no means cold, but only thin and sharp; so much so, that in the *Andes* it pricks and hurts the eyes from its extreme sharpness, and even excites the orifice of the stomach and produces vomiting. The Ancients also observed, that the rarity of the Air on the summit of *Olympus* was such, that those who ascended it were obliged to carry sponges moistened with vinegar *and water*, and to apply them now and then to their nostrils, as the Air was not dense enough for their respiration; on the Summit of which mountain it is also related, there reigned so great a serenity and calm, free from rain, snow, or wind, that the letters traced upon the ashes of the Sacrifices on the Altar of *Jupiter*, by the fingers of those who had offered them, would remain undisturbed till the next year. Those even, who, at this day, go to the top of the *Peak of Teneriffe*, walk by night and not in the day-time, and are advised and pressed by their guides, as soon as the Sun rises, to make haste in their Descent, on account of the Danger (apparently arising from the rarity of the Atmosphere) lest their breathing should be relaxed and suffocated.

3rd negative to the 2nd affirmative. The Reflection of the Solar Rays in the Polar Regions is found to be weak and inefficient in producing Heat; so that the Dutch, who wintered in *Nova Zembla*, and expected that their vessel would be freed about the beginning of July from the obstruction of the mass of ice which had blocked it up, were disappointed and obliged to embark in their boat. Hence the direct rays of the Sun appear to have but little power even on the plain, and when reflected, unless they are multiplied and condensed, which takes place when the Sun tends more to the perpendicular; for then the incidence of the rays occurs at more acute angles, so that the reflected rays are nearer to each other, whilst, on the contrary, when the Sun is in a very oblique position, the angles of incidence are very obtuse and the reflected rays at a greater distance. In the mean time it must be observed, that there may be many operations of the Solar Rays, relating too to the nature of Heat, which are not proportioned to our touch, so that, with regard to us, they do not tend to produce warmth, but, with regard to some other bodies, have their due effect in producing it.

th negative the 2nd irmative. Let the following Experiment be made. Take a lens *the reverse of a* Burning Glass, and place it between the hand and the Solar Rays, and observe whether it diminish the heat of the Sun as a Burning Glass increases it. For it is clear, with regard to the Visual Rays, that in proportion as the lens is made of unequal thickness in the middle and at its Sides, the images appear either more diffused or contracted. It should be seen, therefore, if the same be true with regard to Heat.

5th negative to the 2nd affirmative.

Let the Experiment be well tried, whether the Lunar Rays can be received and collected by the strongest and best Burning Glasses, so as to produce even the least degree of heat. But if that degree be, perhaps, so subtile and weak, as not to be perceived or ascertained by the touch, we must have recourse to those Glasses which indicate the warm or cold state of the Atmosphere, and let the Lunar Rays fall through the Burning Glass on the top of this Thermometer, and then notice if the water be depressed by the heat.[1]

6th negative to the 2nd affirmative.

Let the Burning Glass be tried on Warm Objects which emit no luminous rays, as heated but not ignited Iron or Stone, or hot Water, or the like ; and observe whether the Heat become increased and condensed, as happens with the Solar Rays.

7th negative to the 2nd affirmative.

Let it be tried on common flame.

8th negative to the 3rd affirmative.

The effect of Comets (if we can reckon them amongst Meteors) in augmenting the heat of the season, is not found to be constant or clear, although droughts have generally been observed to follow them. However Luminous Lines, and Pillars, and Openings, and the like, appear more often in winter than in summer, and especially with the most intense cold but joined with drought. Lightning, and Coruscations, and Thunder, however, rarely happen in winter, and generally at the time of the greatest heats.

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[1] For the construction of *Bacon's* Thermometer see No. 38 in the tables of the degrees of Heat. It serves also as a Barometer, but is inaccurate in both capacities.

The appearances we term Falling Stars are generally supposed to consist of some shining and inflamed viscous substance, rather than of violently hot matter. But let this be further investigated.

Some Coruscations emit Light without burning; but are never accompanied by Thunder.

Eructations and eruptions of Flame are to be found in cold Climates as well as in hot, as in *Iceland* and *Greenland*; just as the Trees of cold countries are sometimes inflammable and more pitchy and resinous, than in warm; as the Fir, Pine, and the like. But the position and nature of the Soil, where such eruptions are wont to happen, is not yet sufficiently investigated to enable us to subjoin a *Negative* instance to the *Affirmative*.

All flame is constantly more or less warm, and this instance is not altogether *Negative*. Yet it is said that the Ignis Fatuus (as it is called), and which sometimes is driven against walls, has but little heat; perhaps it resembles that of spirits of wine, which is mild and gentle. That flame, however, appears yet milder, which in some well authenticated and serious Histories, is said to have appeared round the head and hair of Boys and Virgins, and instead of burning their hair, merely to have played about it. And it is most certain that a sort of Flash, without any evident heat, has sometimes been seen about a Horse when sweating at night, or in damp weather. It is also a well known fact,[1] and it was almost considered as a miracle, that a few years since a Girl's Apron sparkled when a little shaken or rubbed; which was perhaps occasioned by the alum or salts with which the apron was imbued, and which after having been stuck together and incrusted rather strongly were broken by the friction. It is well known that all Sugar, whether Candied or plain, if it be hard, will sparkle when broken or scraped in the dark. In like manner Sea and Salt Water is sometimes found to shine at night when struck violently by the oar. The Foam of the Sea when agitated by tempests also Sparkles at night, and the Spaniards call this appearance *the Sea's lungs*. It has not been sufficiently ascertained what degree of heat attends the Flame which the Ancient Sailors called *Castor* and *Pollux*, and the moderns call *St. Ermu's Fire*.

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[1] Was it a *Silk Apron* which exhibited electric Sparks? Silk was *then scarce.*

12th negative to the 7th affirmative.

Every Ignited Body that is red-hot is always Warm, although without flame, nor is any *Negative* instance subjoined to this *Affirmative*. Rotten Wood, however, approaches nearly to it, for it shines at night, and yet is not found to be warm ; and the putrefying scales of Fish which shine in the same manner are not warm to the touch, nor the body of the Glowworm, or of the Fly called Lucciola.[1]

13th negative to the 8th affirmative.

The situation and nature of the Soil of natural warm Baths has not been sufficiently investigated, and therefore a *Negative* instance is not subjoined.

14th negative to the 9th affirmative.

To the instances of warm Liquids we may subjoin the *Negative* one of the peculiar nature of Liquids in general. For no tangible liquid is known that is at once warm in its nature and constantly continues Warm ; but their Heat is only superinduced as an adventitious Nature for a limited time ; so that those which are extremely Warm in their power and effect, as spirits of Wine, chymical aromatic oils, the oils of vitriol and sulphur, and the like, and which speedily burn, are yet cold at first to the touch, and the water of natural Baths, poured into any vessel and separated from its source, cools down like water heated by the fire. It is however true that Oily Substances are rather less cold to the touch than those that are Aqueous, Oil for instance than Water, Silk than Linen ; but this belongs to the *Table of Degrees* of Cold.

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[1] The *Italian* Fire-Fly.

15th negative to the 10th affirmative.

In like manner we may subjoin a *Negative* ins that of warm Vapour, derived from the nature of itself; as far as we are acquainted with it. For exl from Oily Substances, though easily inflammable, never warm unless recently exhaled from son substance.

16th negative to the 10th affirmative.

The same may be said of the instance of Air. never perceive that Air is warm unless confined or or manifestly heated by the Sun, by Fire, or sor warm body.

17th negative to the 11th affirmative.

A *Negative* instance is exhibited in Weather by ness with an East or North Wind, beyond what th would lead us to expect; just as the contrary tak with the South or West winds. An inclination (especially in winter) attends warm weather, and cold weather.

18th negative to the 12th affirmative.

A *Negative* instance as to Air confined in cav be observed in summer. Indeed we should mak diligent inquiry into the nature of confined Air. F first place the qualities of Air in its own nature wi to Heat and Cold, may reasonably be the subject For Air evidently derives its Heat from the Celestial Bodies, and possibly its Cold from the e of the Earth, and in the Mid Region of Air (as it i from cold vapours and snow, so that no judgmen formed of the nature of Air by that which is out and exposed, but a more correct one might be deri confined Air. It is necessary, however, that the A be enclosed in a vessel of such materials as would n it with heat or cold of themselves, nor easily a influence of the external Atmosphere. The Ex should be made therefore with an earthen jar, cov folds of leather to protect it from the external Air, air should be kept three or four days in this ve *closed.* *On* opening the jar, the degree of heat ascertained either by the hand or a graduated glass tube.

19th negative to the 13th affirmative.

There is a similar doubt as to whether the warmth of wool, skins, feathers, and the like, is derived from a slight inherent heat, since they are animal excretions, or from their being of a certain fat and oily nature that accords with heat, or merely from the confinement and separation of Air which we spoke of in the preceding paragraph.[1] For all Air appears to possess a certain degree of warmth when separated from the external Atmosphere. Let an Experiment be made therefore with fibrous substances of linen, and not of wool, feathers, or silk, which are animal excretions. For it is to be observed that all powders (where Air is manifestly enclosed) are less cold than the substances when whole, just as we imagine froth (which contains air) to be less cold than the liquid itself.

20th negative to the 14th affirmative.

We have here no exactly *Negative* instance, for we are not acquainted with any body Tangible or Spirituous which does not admit of heat when exposed to the fire. There is however this difference that some admit it more rapidly, as Air, Oil, and Water, others more slowly, as Stone and Metals.[2] This, however, belongs to the *Table of Degrees*.

21st negative to the 14th affirmative.

No *Negative* is here subjoined, except the remark that sparks are not kindled by flint and steel, or any other hard substance, unless some small particles of the Stone or Metal are struck off, and that the Air never forms them by friction as is commonly supposed; besides, the sparks from the weight of the ignited substance, have a tendency to descend rather than to rise, and when extinguished become a sort of dark ash.

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[1] This last is found to be the real reason, Air not being a good conductor, and therefore not allowing the escape of Heat. The confined Air is disengaged when these substances are placed under an exhausted Receiver.

[2] This is erroneous. *Air* in fact is one of the worst, and *Metals* are the best conductors of Heat.

We are of opinion that here again there is no *Negative*. For we are not acquainted with any tangible body which does not become decidedly warm by friction, so that the Ancients feigned that the Gods had no other means or power of creating heat than the friction of Air, by rapid and violent rotation. On this point, however, further inquiry must be made, whether bodies projected by Machines (as balls from Cannon) do not derive some degree of heat from meeting the air, which renders them somewhat warm when they fall. The Air in motion rather cools than heats, as in the Winds, the Bellows, or breath when the mouth is contracted. The motion, however, in such instances is not sufficiently rapid to excite heat, and is applied to a body of air and not to its component parts, so that it is not surprising that heat should not be generated.

We must make a more diligent inquiry into this Instance. For Herbs, and green and moist Vegetables appear to possess a latent heat, so small however as not to be perceived by the touch in single specimens, but when they are united and confined, so that their spirit cannot exhale into the air, and they rather warm each other, their heat is at once manifested, and even flame occasionally in suitable substances.

Here too we must make a more diligent inquiry. For quick Lime, when sprinkled with water, appears to conceive heat, either from its being collected into one point (as we observed of Herbs when confined), or from the irritation and exasperation of the fiery spirit by water, which occasions a conflict and struggle. The true reason will more readily be shown if Oil be used instead of Water, for Oil will equally tend to collect the confined spirit, but not to irritate. The Experiment may be made more general, both by using the ashes and calcined products of different bodies, and by pouring different liquids upon them.

A *Negative* Instance may be subjoined of other Metals

25th negative to the 19th affirmative.

which are more soft and soluble. For leaf Gold dissolved by Aqua Regia, or lead by Aqua Fortis, are not warm to the touch whilst dissolving, no more is Quicksilver (as far as I remember), but Silver excites a slight heat, and so does Copper, and Tin yet more plainly, and most of all, Iron and Steel, which excite not only a powerful heat but a violent bubbling. The heat therefore appears to be occasioned by the struggle which takes places when these strong Dissolvents penetrate, dig into, and tear asunder the parts of those substances, whilst the substances themselves resist. When, however, the substances yield more easily, scarcely any Heat is excited.

26th negative to the 20th affirmative.

There is no *Negative* Instance with regard to the Heat of Animals, except in Insects (as has been observed), owing to their small-size. For in Fishes, as compared with land Animals, a lower degree rather than a deprivation of heat is observable. In Plants and Vegetables, both as to their exudations and Pith when freshly exposed, there is no sensible degree of Heat. But in Animals there is a great difference in the degree, both in particular parts (for the heat varies near the Heart, the Brain, and the Extremities) and in the Circumstances in which they are placed, such as violent exercise and fevers.

27th negative to the 21st affirmative.

Here again there is scarcely a *Negative* Instance. I might add that the excrements of Animals, even when they are no longer fresh, possess evidently some effective heat, as is shown by their enriching the Soil.

28th negative to the 22nd and 23rd affirmative.

Such Liquids (whether Oily or Watery) as are intensely acrid exhibit the effects of heat, by the separation and burning of bodies after some little action upon them, yet they are not at first warm to the touch. But they act according to their affinity and the pores of the substances to which they are applied. For Aqua Regia dissolves Gold but not Silver, on the contrary, Aqua Fortis dissolves Silver but not Gold; neither of them dissolves Glass, and so of the rest.

29th negative to the 24th affirmative.

Let spirits of wine be tried on Wood, or Butter, Wax, or Pitch, to see if this will melt them at all by their heat. For the 24th Instance shows that they possess properties resembling those of Heat in causing incrustation. Let an Experiment also be made with a Graduated Glass or Calendar[1] concave at the top, by pouring well rectified spirits of wine into the cavity, and covering it up in order that they may the better retain their heat, then observe whether their heat make the water descend.

30th negative to the 25th affirmative.

Spices and acrid Herbs are sensibly warm to the palate, and still more so when taken internally. One should see, therefore, on what other substances they exhibit the effects of heat. Now, Sailors tell us that when large quantities of Spices are suddenly opened, after having been shut up for some time, there is some danger of fever and inflammation to those who stir them or take them out. An Experiment might therefore be made whether such Spices and Herbs when produced will, like Smoke, dry fish and meat hung up over them.

31st negative to the 26th affirmative.

There is an Acrid Effect and a degree of Penetration in Cold Liquids, such as Vinegar and Oil of Vitriol, as well as in Warm, such as Oil of Marjoram and the like. They have, therefore, an equal effect in causing Animated substances to smart, and separating and consuming Inanimate parts. There is not any *Negative* Instance as to this, nor does there exist any Animal Pain unaccompanied by the sensation of heat.

32nd negative to the 27th affirmative.

There are many effects common to Cold and Heat, however, different in their process. For snowballs appear to burn boys' hands after a little time, and cold no less than fire preserves bodies from putrefaction, besides, both Heat and Cold contract bodies. But it is better to refer these instances and the like to the Investigation of Cold.

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[1] *See* No. 38 in the Table of the degrees of Heat.

xiii. In the third place we must *Exhibit to the Understanding* the Instances in which that Nature, which is the object of our Inquiries, is present in a greater or less degree, either by comparing its increase and decrease in the same object, or its degree in different objects. For since the Form of a Thing is its very essence, and the Thing only differs from its Form as the Apparent from the Actual Object, or the Exterior from the Interior, or that which is considered with Relation to Man from that which is considered with Relation to the Universe; it necessarily follows that no Nature can be considered a real Form, which does not uniformly diminish and increase with the given Nature. We are wont to call this our *Table of Degrees* or *Comparative* Instances.

Table of the Degrees or *Comparative Instances* of Heat

We will first speak of those bodies which exhibit no degree of Heat sensible to the touch, but appear rather to possess a potential heat, or disposition and preparation for it. We will then go on to others, which are actually Warm to the touch, and observe the strength and Degree of it.

1. There is no known solid or tangible body which is by its own Nature originally Warm. For neither stone, metal, sulphur, fossils, wood, water, nor dead animal carcasses, are found Warm. The warm Springs in Baths appear to be heated accidentally, by flame, subterraneous fire (such as is thrown up by Etna and many other mountains), or by the contact of certain bodies, as Heat is exhibited in the dissolution of iron and tin. The degree of Heat therefore in Inanimate objects is not sensible to our touch, but they differ in their Degrees of Cold, for wood and metal are not

equally cold. This, however, belongs to the *Table of degrees of Cold.*

2. But with regard to potential Heat and predisposition to flame, we find many inanimate substances wonderfully adapted to it: as Sulphur, Naphtha, and Saltpetre.

3. Bodies which have previously required Heat, as horse-dung from the animal, or lime, and perhaps ashes and soot from fire, retain some latent portion of it. Hence distillations and separations of substances are effected by burying them in horse-dung, and heat is excited in lime by sprinkling it with water (as has been before observed).

4. In the Vegetable world we know of no Plant, nor part of any Plant (as the exudations or pith) that is warm to man's touch. Yet (as we have before observed) green weeds grow warm when confined, and some vegetables are warm and others cold to our internal touch, i.e. the palate and stomach, or even after a while to our external skin (as is shown in plasters and ointments).

5. We know of nothing in the various parts of animals, when dead or detached from the rest, that is warm to the touch. For horse-dung itself does not retain its heat, unless it be confined and buried. All dung, however, appears to possess a potential heat, as in manuring fields. So also dead bodies are endued with this latent and potential heat, to such a degree that in Cemeteries where people are interred daily, the Earth acquires a secret heat which consumes any recently deposited body much sooner than pure earth: and they tell you that the People of the East are acquainted with a fine soft cloth, made of the down of birds, which can melt butter wrapt gently up in it by its own warmth.

6. Manures, such as every kind of Dung, Chalk, Sea-sand, Salt, and the like, have some disposition towards Heat.

7. All putrefaction exhibits some slight degree of

Heat, though not enough to be perceptible by the touch. For neither the substances, which by putrefaction are converted into animalculæ, as Flesh and Cheese, nor rotten wood which shines in the dark, are Warm to the touch. The Heat, however, of putrid substances displays itself occasionally in a disgusting and strong scent.

8. The first degree of Heat therefore in substances which are Warm to the human touch, appears to be that of animals, and this admits of a great variety of degrees, for the lowest (as in insects) is scarcely perceptible, the highest scarcely equals that of the Sun's rays in warm climates and weather, and is not so acute as to be insufferable to the hand. It is said however of *Constantius*, and some others of a very dry Constitution and habit of Body, that when attacked with violent fevers, they became so warm as to appear almost to burn the hand applied to them.

9. Animals become more Warm by Motion and exercise, wine and feasting, venery, burning fevers, and grief.

10. In the paroxysm of intermittent fevers the Patients are at first seized with cold and shivering, but soon afterwards become more heated than at first; in Burning and pestilential fevers they are hot from the beginning.

11. Let further inquiry be made into the comparative Heat of different animals, as fishes, quadrupeds, serpents, birds: and also of the different species, as the Lion, the Kite, or Man. For according to the vulgar opinion fishes are the least Warm internally, and birds the most; particularly Doves, Hawks, and Ostriches.

12. Let further inquiry be made as to the comparative Heat in different parts and limbs of the same animal. For milk, blood, seed, and eggs are moderately warm, and less Hot than the outward flesh of the animal when in motion or agitated. The degree of Heat of the brain, stomach, heart, and the rest, has not yet been equally well investigated.

13. All animals are Externally cold in winter and cold weather, but are thought to be Internally Warmer.

14. The heat of the Heavenly Bodies, even in the warmest climates and Seasons, never reaches such a pitch as to light or burn the dryest wood or straw, or even tinder without the aid of burning glasses. It can, however, raise vapour from moist substances.

15. Astronomers tell us that some stars are Hotter than others. *Mars* is considered the warmest after the *Sun*, then *Jupiter*, then *Venus*. The *Moon* and, above all, *Saturn* are considered to be cold. Among the fixed stars, Sirius is thought the warmest, then Cor Leonis, or Regulus, then the lesser Dog-star.

16. The Sun gives out more heat as it approaches towards the perpendicular or Zenith, which may be supposed to be the case with the other Planets according to their degree of heat ; for instance, that *Jupiter* gives out more heat when situated beneath Cancer or Leo, than when he is beneath Capricorn and Aquarius.

17. It is to be supposed that the Sun and other Planets give more heat in Perigee, from their approximation to the earth, than when in Apogee. But if in any country the Sun should be both in its Perigee and nearer to the perpendicular at the same time, it must necessarily give out more heat than in a country where it is also in Perigee, but situated more obliquely. So that the Comparative altitude of the Planets should be observed, and their approach to or declination from the perpendicular in different countries.

18. The Sun[1] and other Planets are thought also to give out more heat in proportion as they are nearer to the

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[1] This notion is erroneous, but the Sun is in *Leo* about August, when the Earth has become heated, by the accumulation of Heat after the Solstice. The maximum of Heat in the day is not at noon but *about two o'clock*, for the same reason.

larger fixed Stars; as when the Sun is in Leo he is nearer Cor Leonis, Cauda Leonis, Spica Virginis, Sirius, and the lesser Dog-star, than when he is in Cancer, where, however, he approaches nearer to the perpendicular. It is probable also that the quarters of the Heavens produce a greater heat (though not perceptibly), in proportion as they are adorned with a greater number of Stars, particularly those of the first magnitude.

19. On the whole the Heat of the Heavenly Bodies is augmented in three ways; 1. The approach to the perpendicular; 2. Proximity or their Perigee; 3. The conjunction or union of Stars.

20. There is a very considerable difference between the degree of Heat in Animals, and even in the rays of the Heavenly Bodies (as they reach us), and the heat of the most gentle flame, and even of all Ignited Substances, nay liquids, or the Air itself when unusually heated by fire. For the flame of spirit of wine, though diffused and uncollected, is yet able to set straw, linen, or paper on fire, which Animal Heat, or that of the Sun, will never accomplish without a burning glass.

21. There are however many degrees of strength and weakness in Flame and Ignited Bodies: but no diligent Inquiry has been made in this respect, and we must, therefore, pass it hastily over. Of all flames that of spirits of wine appears to be the most gentle, except, perhaps, the Ignis Fatuus, or the flashes from the perspiration of animals. After this we should be inclined to place the flame of light and porous vegetables, such as straw, reeds, and dried leaves; from which the flame of hair or feathers differs but little. Then, perhaps, comes the flame of wood, particularly that which contains but little rosin or pitch, that of small wood, however (such as is usually tied up in faggots), is milder than that of the trunks or roots of trees. This can be easily tried *in iron* furnaces, where a fire of faggots or

branches of trees is of little service. Next follows the flame of oil, tallow, wax, and the like oily and fat substances, which are not very violent. But a most powerful Heat is found in pitch and rosin, and a still greater in Sulphur, Camphire, Naphtha, Saltpetre, and Salts (after they have discharged their crude matter), and in their compounds; as in Gunpowder, *Greek* Fire (vulgarly called wild Fire), and its varieties, which possess such a stubborn Heat as scarcely to be extinguished by water.

22. We consider that the flame which results from some imperfect metals is very strong and active: but on all these points further inquiry should be made.

23. The flame of vivid lightning appears to exceed all the above, so as sometimes to have melted even wrought iron into drops, which the other flames cannot accomplish.

24. In Ignited Bodies there are different degrees of Heat, concerning which also a diligent inquiry has not been made. We consider the faintest Heat to be that of tinder, touchwood, and dry rope match, such as is used for discharging cannon. Next follows that of ignited charcoal, or cinders, and even bricks, and the like; but the most violent is that of ignited metals, as Iron, Copper, and the like. Further inquiry, however, must be made into this also.

25. Some Ignited Bodies are found to be much Warmer than some flames; for instance, Red Hot Iron is much Warmer and burns more than the flame of spirits of wine.

26. Some bodies even not Ignited, but only Heated by the fire, as boiling Water, and the Air confined in reverberatories, surpass in Heat many flames and Ignited Substances.

27. Motion increases Heat, as is shown in the bellows and the blow-pipe, for the harder Metals are not dissolved or melted by steady quiet fire, without the aid of the blow-pipe.

28. Let an Experiment be made with burning glasses; in which respect I have observed, that if a glass be placed at the distance of ten inches, for instance, from the combustible object, it does not kindle or burn it so readily, as if the glass be placed at the distance of five inches (for instance), and be then gradually and slowly withdrawn to the distance of ten inches. The Cone and focus of the rays, however, are the same, but the mere Motion increases the effect of the Heat.

29. Conflagrations, which take place with a high wind, are thought to make greater way against than with the wind, because when the wind slackens the flame recoils more rapidly than it advances when the wind is favourable.

30. Flame does not burst out or arise unless it have some hollow space to move and exert itself in, except in the exploding flame of Gunpowder, and the like, where the compression and confinement of the flame increase its fury.

31. The Anvil becomes so hot by the hammer, that if it were a thin plate it might probably grow red like ignited iron by repeated strokes. Let the Experiment be tried.

32. But in Ignited Bodies that are porous, so as to leave room for the fire to move itself, if its motion be prevented by strong compression, the fire is immediately extinguished; thus it is with tinder, or the burning snuff of a candle or lamp, or even hot charcoal or cinders, for when they are squeezed by snuffers, or the foot, and the like, the effect of the Fire instantly ceases.

33. The approach towards a Hot Body increases Heat in proportion to the approximation; a similar effect to that of light, for the nearer any object is placed towards the light, the more visible it becomes.

34. The[1] union of different Heats increases heat,

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[1] The Fires supply fresh Heat, the Water has only a certain quantity of Heat, which being diffused over a fresh supply of cooler Water must be on the whole lowered.

unless the substances be mixed. For a large and small fire in the same spot tend mutually to increase each other's Heat, but lukewarm water poured into boiling water cools it.

35. The continued neighbourhood of a warm body increases Heat. For the Heat, which perpetually passes and emanates from it, being mixed with that which preceded it, multiplies the whole. A fire, for instance, does not warm a room in half an hour, as much as the same fire would in an hour. This does not apply to light, for a lamp or candle placed in any spot gives no more light by remaining there, than it did at first.

36. The irritation of surrounding cold increases Heat, as may be seen in fires during a sharp frost. We think that this is owing not merely to the confinement and compression of the Heat (which forms a sort of union); but also by the exasperation of it, as when the Air or a stick are violently compressed or bent, they recoil, not only to the point they first occupied, but still further back. Let an accurate Experiment, therefore, be made with a stick, or something of the kind, put into the flame, in order to see whether it be not sooner burnt at the sides than in the middle of it.[1]

37. There are many degrees in the susceptibility of Heat. And, first, it must be observed how much a low gentle Heat changes and partially warms even the bodies least susceptible of it. For even the heat of the hand imparts a little warmth to a ball of lead or other Metal held a short time in it. So easily is Heat transmitted and excited, without any apparent change in the body.

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[1] If condensation were the cause of the greater Heat, *Bacon* concludes the centre of the Flame would be the hotter part, and vice versa. The fact is, neither of the causes assigned by *Bacon* is the true one; for the fire burns more quickly only because the draught of Air is more rapid, the cold dense Air pressing rapidly into the heated room and towards the chimney.

38. Of all bodies that we are acquainted with, Air admits and loses Heat the most readily, which is admirably seen in Weather-Glasses, whose construction is as follows. Take a glass with a hollow belly, and a thin and long neck; turn it upside down, and place it with its mouth downwards into another glass vessel containing Water; the end of the tube touching the bottom of the vessel, and the tube itself leaning a little on the edge, so as to be fixed upright. In order to do this more readily, let a little wax be applied to the edge, not however so as to block up the orifice, lest by preventing the Air from escaping, the motion, which we shall presently speak of, and which is very gentle and delicate, should be impeded.

Before the first glass be inserted in the other, its upper part (the belly) should be warmed at the fire. Then upon placing it as we have described, the Air (which was dilated by the heat), after a sufficient time has been allowed for it to lose the additional temperature, will restore and contract itself to the same dimensions as that of the external or common Atmosphere at the moment of immersion, and the water will be attracted upwards in the tube to a proportionate extent. A long narrow slip of paper should be attached to the tube, divided into as many degrees as you please. You will then perceive, as the weather grows Warmer or Colder, that the Air contracts itself into a narrower space in cold weather and dilates in the warm, which will be exhibited by the rising of the water as the Air contracts itself, and its depression as the Air dilates. The sensibility of the Air with regard to Heat or Cold is so delicate and exquisite, that it far exceeds the human touch, so that a ray of Sunshine, the heat of the breath, and much more, that of the hand placed on the top of the tube, immediately causes an evident depression of the water. We think, however, that the spirit of animals possesses a much more delicate susceptibility of Heat and Cold, only that it is impeded and blunted by the grossness of their bodies.

39. After Air we consider those bodies to be most sensible of Heat which have been recently changed and contracted by cold, as Snow and Ice; for they begin to be dissolved and melt with the first mild weather. Next, perhaps, follows Quicksilver; then greasy substances, as oil, butter, and the like; then Wood; then Water; lastly, Stones and Metals, which do not easily grow hot, particularly towards their centre.[1] When Heated, however, they retain their temperature for a very long time; so that a brick or stone, or hot iron, plunged in a basin of cold water, and kept there for a quarter of an hour or thereabouts, retains such a Heat as not to admit of being touched.

40. The less massive the body is, the more readily it grows warm at the approach of a heated body, which shows that Heat with us is somewhat averse to a tangible mass.[2]

41. Heat with regard to the human senses and touch is various and relative, so that lukewarm water appears hot if the hand be cold, and cold if the hand be hot.

xiv. Any one may readily see how poor we are in history, since in the above *Tables*, besides occasionally inserting traditions and report instead of approved history and

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[1] *Bacon* appears to have confounded combustibility and fusibility with susceptibility of Heat; for though the Metals will certainly neither dissolve as soon as Ice or Butter, nor be consumed as soon as Wood, that only shows that different degrees of Heat are required to produce similar effects on different Bodies; but Metals much more readily acquire and transmit the same degree of Heat than any of the above substances. The rapid transmission renders them generally cold to the touch. The convenience of fixing wooden handles to vessels containing hot water illustrates these observations.

[2] Another singular Error, the truth being that Solid Bodies are the best Conductors; but of course where Heat is diffused over a large mass, it is less in each part, than if that part also alone received the *whole quantum* of Heat.

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authentic Instances (always, however, adding some note if their credit or Authority be doubtful), we are often forced to subjoin *Let the experiment be tried.—Let further inquiry be made.*

xv. We are wont to term the office and Use of these three Tables the *presenting a review of Instances to the understanding;* and when this has been done *Induction* itself is to be brought into action. For on an individual *Review* of all the Instances a Nature is to be Found, such as always to be present and absent with the given nature, to increase and decrease with it, and as we have said to form a more common limit of the Nature. If the mind attempt this affirmatively from the first (which it always will when left to itself), there will spring up phantoms, mere theories and ill-defined Notions, with Axioms requiring daily correction. These will doubtless be better or worse according to the power and strength of the understanding which creates them. But it is only for God (the Bestower and Creator of Forms), and perhaps for Angels and Intelligences, at once to recognise Forms Affirmatively at the first glance of Contemplation: man at least is unable to do so, and is only allowed to proceed first by *Negatives*, and then to conclude with *Affirmatives*, after every species of exclusion.

xvi. We must therefore effect a complete solution and separation of Nature; not by Fire, but by the Mind, that divine Fire. The first work of legitimate *Induction*, in the discovery of Forms, is *Rejection*, or the *Exclusive Instances* of Individual Natures, which are not found in some one Instance where the given Nature is present, or are found in any one Instance where it is absent, or are found to increase in any one Instance where the given Nature decreases or the reverse. After an *Exclusion* correctly effected, an affirmative Form will remain as the residuum, solid, true, and well defined, whilst all volatile opinions go off in smoke. This is readily said, but we must arrive at it by a cir route. We shall perhaps, however, omit nothing that can facilitate our progress.

xvii. The first and almost perpetual Precaution and warning which we consider necessary is this: that none should suppose from the great part assigned by us to Forms, that we mean such Forms as the meditations and thoughts of men have hitherto been accustomed to. In the first place we do not at present mean the concrete Forms, which (as we have observed) are in the common course of things Compounded of simple Natures, as those of a Lion, an Eagle, a Rose, Gold, or the like. The Moment for discussing these will arrive when we come to treat of the *latent Process*, and *latent Conformation*, and the discovery of them as they exist in what are called substances, or concrete Natures.

Nor again would we be thought to mean (even when treating of simple Natures) any abstract forms or Ideas, either undefined or badly defined in matter. For when we speak of Forms, we mean nothing else than those laws and regulations of simple Action which arrange and constitute any simple Nature, such as heat, light, weight, in every species of matter and in a susceptible subject. The Form of Heat or Form of Light, therefore, means no more than the Law of Heat, or the Law of Light. Nor do we ever abstract or withdraw ourselves from things, and the operative branch of philosophy. When therefore we say (for instance) in our Investigation of the Form of Heat, *Reject rarity*, or *rarity is not of the Form of Heat*, it is the same as if we were to say, *Man can superinduce Heat on a dense body*, or the reverse, *Man can abstract or ward off Heat from a rare body*.

But if our Forms appear to any one to be somewhat abstracted, from their mingling and uniting heterogeneous objects (the Heat for instance of the Heavenly Bodies appears to be very different from that of Fire; the fixed red of the rose and the like, from that which is apparent in the Rainbow, or the radiation of Opal or the Diamond;[1] Death by drowning, from that by burning, the sword, Apoplexy, or Consumption; and yet they all agree in the common Natures of Heat, Redness, and Death), let him be assured that his understanding is enthralled by habit, by general appearances and hypotheses. For it is most certain that, however heterogeneous and distinct, they agree in the Form or Law which regulates Heat, redness, or death; and that human power cannot be emancipated and freed from the common course of Nature, and expanded and exalted to new Efficients and new Modes of operation, except by the revelation and invention of Forms of this nature. But after[2] this union of Nature, which is the principal point, we will afterwards, in its proper place, treat of the divisions and ramifications of Nature, whether ordinary or internal and more real.

xviii. We must now offer an Example of the *Exclusion* or *Rejection* of Natures found by the *Tables of Review*, not to be of the Form of Heat; first premising that not only each *Table* is sufficient for the *Rejection* of any Nature, but even each single Instance contained in them. For it is Clear from what has been said that every *contradictory Instance* destroys an hypothesis as to the Form. Still, however, for the sake of clearness, and in order to show more plainly the use of the *Tables*, we redouble or repeat the *Exclusive*.

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[1] This general law or form has been well illustrated by *Newton's* discovery of the decomposition of Colours.

[2] i.e. the common link or *Form* which connects the various kinds of Natures, such as the different hot or red Natures enumerated above. See *Aphorism* 3, Part 2.

An Example of the *Exclusive Table* or of the *Rejection of Natures* from the Form of Heat

1. On account of the Sun's rays *Reject* Elementary (or Terrestrial) Nature.

2. On account of common Fire, and particularly subterranean Fires (which are the most remote and secluded from the rays of the Heavenly Bodies), *Reject* Celestial Nature.

3. On account of the Heat acquired by every description of substances (as Minerals, Vegetables, the external parts of Animals, Water, Oil, Air, &c.) by mere approximation to the Fire or any warm Body, *Reject* all Variety and delicate Texture of bodies.

4. On account of Iron and ignited Metals, which warm other bodies, and yet neither lose their weight nor substance, *Reject* the imparting or mixing of the substance of the Heating Body.

5. On account of boiling Water and Air, and also those Metals and other Solid Bodies which are heated, but not to ignition, or red heat, *Reject* Flame or Light.

6. On account of the rays of the Moon and other Heavenly Bodies (except the Sun), again *Reject* Flame or Light.

7. On account of the *Comparison* between red-hot Iron and the Flame of spirits of wine (for the Iron is more hot and less bright, whilst the Flame of spirits of wine is more bright and less hot), again *Reject* Flame and Light.

8. On account of Gold and other ignited Metals, which are of the greatest specific density, *Reject* Rarity.

9. On account of Air, which is generally found to be cold and yet continues rare, *Reject* Rarity.

10. On account of ignited Iron,[1] which does not swell

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[1] *This is erroneous*: all Metals expand considerably when heated.

in bulk, but retains the same apparent dimension, *Reject* the absolute expansive Motion of the whole.

11. On account of the expansion of the Air in Thermometers, and the like, which is absolutely moved and expanded to the eye, and yet acquires no manifest increase of Heat, again *Reject* absolute or expansive Motion of the whole.

12. On account of the ready application of Heat to all substances without any destruction or remarkable alteration of them, *Reject* destructive Nature or the violent communication of any new Nature.

13. On account of the Agreement and Conformity of the effects produced by Cold and Heat, *Reject* both Expansive and Contracting Motion as regards the whole.

14. On account of the Heat Excited by friction, *Reject* Principal Nature, by which we mean that which exists Positively, and is not caused by a preceding Nature.

There are other Natures to be rejected; but we are merely offering Examples and not perfect Tables.

None of the above Natures are of the Form of Heat; and Man is freed from them all in his operation upon Heat.

xix. In the *Exclusive Table* are laid the foundations of true *Induction*, which is not however completed until the Affirmative be attained. Nor is the *Exclusive Table* perfect, nor can it be so at first. For it is clearly a *Rejection* of Simple Natures; but if we have not as yet good and just Notions of simple Natures, how can the *Exclusive Table* be made correct? Some of the above, as the Notion of Elementary and Celestial Nature, and Rarity, are Vague and ill-defined. We, therefore, who are neither ignorant nor forgetful of the great work which we attempt, in rendering the human Understanding adequate to Things and Nature, by no means rest satisfied with what we have hitherto enforced; but push the matter farther, and contrive and prepare more powerful aid for the use of the Understanding, which we will next subjoin. And, indeed, in the *Interpretation of Nature* the mind is to be so prepared and formed, as to rest itself on proper degrees of certainty, and yet to remember (especially at first) that what is present depends much upon what remains behind.

xx. Since, however, Truth emerges more readily from error than confusion, we consider it useful to leave the Understanding at liberty to exert itself and attempt the *Interpretation of Nature* in the affirmative, after having constructed and weighed the three Tables of preparation, such as we have laid them down, both from the Instances there collected, and others occurring elsewhere. Which Attempt we are wont to call the *Liberty of the Understanding*, or the *commencement of Interpretation*, or the *first Vintage.*

The first Vintage of the Form of Heat

It must be observed that the Form of any thing is inherent (as appears clearly from our premises) in each individual Instance in which the Thing itself is inherent, or it would not be a Form. No contradictory *Instance*, therefore, can be alleged. The Form, however, is found to be much more conspicuous and evident in some *Instances* than in others ; in those (for example) where its Nature is less restrained and embarrassed, and reduced to rule by other Natures. Such Instances we are wont to term *Coruscations*, or *Conspicuous Instances.* We must proceed then to the *first Vintage* of the Form of Heat.

From the *Instances* taken collectively, as well as singly, the Nature whose limit is Heat appears to be Motion. This is chiefly exhibited in Flame, which is in constant motion, and in warm or boiling Liquids, which are likewise in constant motion. It is also shown in the excitement or increase *of Heat* by motion, as by Bellows and draughts : for which see *Inst.* 29, *Tab.* 3, and by other species of Motion, as in *Inst.* 28 and 31, *Tab.* 3. It is also shown by the extinction of Fire and Heat upon any strong pressure, which restrains and puts a stop to Motion ; for which see *Inst.* 30 and 32, *Tab.* 3. It is further shown by this circumstance, namely, that every substance is destroyed, or at least materially changed, by strong and powerful Fire and Heat : whence it is clear that tumult and confusion are occasioned by Heat, together with a violent motion in the internal parts of Bodies, and this gradually tends to their dissolution.

What we have said with regard to Motion must be thus understood, when taken as the Genus of Heat : it must not be thought that Heat generates Motion, or Motion Heat (though in some respects this be true), but that the very essence of Heat, or the *Substantial self*[1] of Heat, is Motion and nothing else, limited, however, by certain *Differences* which we will presently add, after giving some cautions for avoiding Ambiguity.

Sensible Heat is Relative, and regards Man, not the Universe ; and is rightly held to be merely the Effect of Heat on Animal spirit. It is even variable in itself, since the same body (in different states of Sensation) excites the feeling of Heat and of Cold ; this is shown by *Inst.* 41, *Tab.* 3.

Nor should we confound the communication of Heat or its Transitive Nature, by which a body grows warm at the approach of a heated body, with the form of Heat. For Heat is one thing and Heating another. Heat can be excited by Friction without any previous Heating Body, and, therefore, Heating is excluded from the Form of Heat. Even when Heat is excited by the approach of a Hot Body, this depends not on the form of Heat, but on another more profound and common Nature ; namely, that of Assimilation and Multiplication, about which a separate inquiry must be made.

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[1] '*Quid ipsum,*' the τὸ τὶ ἦν εἶναι of *Aristotle.*

The notion of Fire is vulgar, and of no assistance; it is merely compounded of the conjunction of Heat and Light in any body, as in ordinary Flame and red-hot substances.

Laying aside all Ambiguity, therefore, we must lastly consider the true *Differences* which limit Motion and render it the Form of Heat.

I. The *First Difference* is, that Heat is an Expansive Motion, by which the body strives to dilate itself, and to occupy a greater space than before. This *Difference* is principally seen in flame, where the smoke or thick vapour is clearly dilated and bursts into flame.

It is also shown in all boiling Liquids, which swell, rise, and boil up to the sight, and the process of expansion is urged forward till they are converted into a much more extended and dilated body than the Liquid itself, such as Steam, Smoke, or Air.

It is also shown in Wood and Combustibles where exudation sometimes takes place, and evaporation always.

It is also shown in the melting of Metals, which, being very compact, do not easily swell and dilate, but yet their Spirit, when dilated and desirous of further expansion, forces and urges its thicker parts into Dissolution, and if the Heat be pushed still farther, reduces a considerable part of them into a volatile state.

It is also shown in Iron or Stones, which, though not melted or dissolved, are however softened. The same circumstance takes place in sticks of wood, which become flexible when a little heated in warm ashes.

It is most readily observed in Air, which instantly and manifestly expands with a small degree of heat, as in *Inst.* 38, *Tab.* 3.

It is also shown in the contrary nature of Cold. For Cold contracts and narrows every substance; so that in intense Frosts nails fall out of the wall and brass cracks, and heated glass exposed suddenly to the Cold cracks and breaks. So the Air by a slight degree of cold contracts itself, as in *Inst.* 38, *Tab.* 3. More will be said of this in the inquiry into Cold.

Nor is it to be wondered at if Cold and Heat exhibit many common effects (for which see *Inst.* 32, *Tab.* 2), since two *Differences*, of which we shall presently speak, belong to each Nature: although in the present *Difference* the effects be diametrically opposed to each other. For Heat occasions an expansive and dilating motion, but Cold a contracting and condensing motion.

II. The *Second Difference* is a modification of the preceding, namely, that Heat is an expansive Motion, tending towards the exterior, but at the same time bearing the body upwards. For there is no Doubt that there be many compound Motions; as an arrow or dart, for instance, has both a rotatory and progressive motion. In the same way the Motion of Heat is both Expansive and tending Upwards.

This *Difference* is shown by putting the Tongs or Poker into the fire. If placed perpendicularly with the hand above, they soon burn it, but much less speedily if the hand hold them sloping or from below.

It is also Conspicuous in *Distillations* per Descensum, which men are wont to employ with delicate Flowers, whose scent easily evaporates. Their industry has devised placing the Fire above instead of below, that it may scorch less. For not only Flame but all Heat has an upward tendency.

Let an Experiment be made on the contrary Nature of Cold; whether its contraction be downwards, as the expansion of Heat is upwards. Take therefore two iron rods or two glass tubes, alike in other respects, and warm them a little, and place a sponge, dipt in cold water, or some snow below the one and above the other. We are of opinion that the extremities will grow Cold in that rod first where it is placed beneath; as the contrary takes place with regard to Heat.

III. The *Third Difference* is this. That Heat is not a uniform Expansive Motion of the whole, but of the small particles of the body; and this Motion being at the same time restrained, repulsed, and reflected, becomes alternating, perpetually hurrying, striving, struggling, and irritated by the repercussion; which is the source of the violence of Flame and Heat.

But this *Difference* is chiefly shown in Flame and boiling Liquids, which always hurry, swell, and subside again in detached parts.

It is also shown in bodies of such hard texture as not to swell or dilate in bulk, such as red-hot Iron, in which the Heat is most violent.

It is also shown by the fires burning most briskly in the coldest weather.

It is also shown by this; that when the Air is dilated in the Thermometer uniformly and equably, without any impediment or repulsion, the Heat is not perceptible. In confined draughts also, although they break out very violently, no remarkable Heat is perceived, because the Motion affects the whole, without any alternating Motion in the particles. For which reason try whether Flame do not burn more at the sides that in its centre.

It is also shown in this, that all burning proceeds by the minute pores of bodies, undermining, penetrating, piercing, and pricking them as if with an infinite number of needle-points. Hence all strong Acids (if adapted to the body on which they act) exhibit the effects of Fire from their corroding and pungent nature.

The *Difference* of which we now speak is common also to the nature of Cold, in which the contracting Motion is restrained by the resistance of expansion, as in Heat the expansive Motion is restrained by the resistance of contraction.

Whether, therefore, the particles of matter penetrate inwards or outwards the reasoning is the same, though the power be very different, because we have nothing on Earth which is intensely Cold. See *Inst.* 27, *Tab.* 9.

IV. The *Fourth Difference* is a modification of the preceding; namely, that this Stimulating or Penetrating Motion should be rapid and never sluggish, and should take place not in the very minutest particles, but rather in those of some tolerable dimensions.

It is shown by comparing the effects of Fire with those of Time. Time dries, consumes, undermines, and reduces to ashes as well as Fire, and perhaps to a much finer degree, but as its Motion is very slow, and attacks very minute particles, no Heat is perceived.

It is also shown in a comparison of the dissolution of Iron and Gold. For Gold is dissolved without the excitement of any Heat, but Iron with a vehement excitement of it, although almost in the same time: because, in the former, the penetration of the Separating Acid is mild, and gently insinuates itself, and the particles of Gold yield easily, but the penetration of Iron is violent, and attended with some struggle, and its particles are more obstinate.

It is partially shown also in some Gangrenes and Mortifications of flesh, which do not excite great heat or pain from the gentle nature of the putrefaction.

Let this suffice for a *First Vintage*, or the *Commencement of the Interpretation* of the Form of Heat by the *Liberty of the Understanding.*

From this *First Vintage* the Form or true Definition of Heat (considered relatively to the Universe and not to the Sense) is briefly thus. *Heat is an Expansive Motion restrained, and striving to exert itself in the smaller particles.* The *Expansion* is Modified by *its tendency to rise* though *expanding towards the exterior;* and the Effort is modified by *its not being sluggish, but active and somewhat violent.*

With regard to the Operative Definition, the matter is the same. *If you are able to excite a dilating or expansive Motion in any natural body, and so to repress that Motion and force it on itself as not to allow the expansion to proceed equally, but only to be partially exerted, and partially repressed, you will, beyond all doubt, produce Heat;* without any consideration as to whether the body be of earth (or Elementary as they term it) or imbued with Celestial Influence, luminous or opaque, rare or dense, locally expanded or contained within the bounds of its first dimensions, verging to dissolution or remaining fixed, Animal, Vegetable, or Mineral, Water, or Oil, or Air, or any other substance whatever susceptible of such Motion. Sensible Heat is the same, but considered relatively to the Senses. Let us now proceed to further helps.

xxi. After our *Tables of first Review*, our *Rejection* or *Exclusive* table, and the *first Vintage* derived from them, we must advance to the remaining helps of the Understanding with regard to the *Interpretation of Nature*, and a true and perfect *Induction;* in offering which we will take the examples of Cold and Heat where Tables are necessary, but where fewer Instances are required we will go through a variety of others; so as neither to confound Investigation nor to narrow our Doctrine.

In the first place, therefore, we will treat of *Prerogative Instances;* 2. Of the *Supports of Induction;* 3. Of the *Correction of Induction;* 4. Of *Varying the Investigation according to the Nature of the Subject;* 5. Of the *Prerogative Natures* with respect to Investigation, or of what should be the first or last objects of our research; 6. Of the *Limits of Investigation*, or a *Synopsis* of all *Natures* that exist in the Universe; 7. Of the *Application to Practical Purposes*, or of what Relates to Man; 8. Of the *Preparations for Investiga-*

tion; 9. And, lastly, *of the Ascending and Descending Scale of Axioms.*

xxii. Amongst the *Prerogative Instances* we will first mention *Solitary Instances.* *Solitary* instances are those which exhibit the required Nature in Subjects that have nothing in common with any other Subject than the Nature in Question; or which do not exhibit the required Nature in Subjects resembling others in every respect except that of the Nature in Question. For these Instances manifestly remove prolixity, and accelerate and confirm *Exclusion*, so that a few of them are of as much avail as many.

For instance: let the Inquiry be the Nature of *Colour.* Prisms, Crystalline Gems, which yield colours not only internally but on the wall, Dews, &c. are *Solitary Instances.* For they have nothing in common with the fixed colours in Flowers and coloured Gems, Metals, Woods, &c. except the colour itself. Hence we easily deduce that Colour is nothing but a Modification of the image of the Incident and absorbed light, occasioned in the former case by the different degrees of incidence, in the later by the various Textures and Forms of bodies.[1] These are *Solitary Instances* as regards similitude.

Again, in the same Inquiry, the distinct veins of White and Black in Marble, and the variegated colours of Flowers of the same species, are *Solitary Instances*: for the Black and White of Marble, and the Spots of White and Purple in the flowers of the Stock, agree in every respect but that of colour. Thence we easily deduce that Colour has not much to do with the intrinsic Natures of any body, but depends only on the coarser and as it were Mechanical Arrangement of the parts. These are *Solitary Instances* as regards difference. We call them both *Solitary* or *Wild*, to borrow a word from the Astronomers.

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[1] This very nearly approaches to *Sir I. Newton*'s discovery of the *decomposition of Light* by the Prism.

xxiii. In the second rank of prerogative Instances we will consider *Migrating Instances.* In these the Required Nature passes towards generation, having no previous existence, or towards corruption, having first existed. In each of these Divisions, therefore, the Instances are always twofold, or rather it is one Instance, first in motion or on its passage, and then brought to the opposite conclusion. These Instances not only hasten and confirm *Exclusion* but also reduce *Affirmation*, or the Form itself to a narrow compass. For the Form must be something conferred by this *Migration*, or on the contrary removed and destroyed by it. And although all Exclusion advances *Affirmation*, yet this takes place more directly in the same than in different subjects. But if the Form (as it is quite clear from what has been advanced) exhibit itself in one subject, it leads to all. The more simple the *Migration* is, the more valuable is the Instance. These *Migrating Instances* are, moreover, very useful in Practice, for since they manifest the Form, coupled with that which Causes or Destroys it, they point out the right practice in some subjects, and thence there is an easy transition to those with which they are most allied. There is, however, a degree of danger which demands caution, namely, lest they should refer the Form too much to its Efficient cause, and imbue or, at least, tinge the Understanding with a false notion of the Form from the appearance of such Cause ; which is never more than a vehicle or conveyance of the Form This may easily be remedied by a proper application of *Exclusion.*

Let us then give an Example of a *Migrating Instance.* Let Whiteness be the Required Nature. An *Instance* which *passes* towards generation is glass in its entire and in its powdered state ; or Water in its natural state, and when agitated to froth. For glass when entire, and Water in its natural state, are Transparent and not White, but powdered glass and the froth of Water are White and not Transparent.

We must inquire, therefore, what has happened to the Glass or Water in the course of this *Migration*. For it is manifest that the Form of Whiteness is conveyed and introduced by the bruising of the Glass, and the agitation of the Water. But nothing is found to have been introduced but a diminishing of the parts of the Glass and Water, and the insertion of Air. Yet this is no slight progress towards discovering the Form of Whiteness, namely, that two bodies in themselves more or less Transparent (as Air and Water, or Air and Glass), when brought into contact in minute portions exhibit Whiteness, from the unequal refraction of the rays of light.

But here we must also give an Example of the danger and caution of which we spoke. For instance; it will readily occur to an Understanding perverted by Efficients, that Air is always necessary for producing the Form of Whiteness, or that Whiteness is only generated by Transparent bodies, which suppositions are both false, and proved to be so by many Exclusions. Nay, it will rather appear (without any particular regard to Air or the like) that all bodies which are even in such of their parts as affect the Sight exhibit Transparency, those which are uneven and of simple texture Whiteness, those which are uneven and of compound but regular texture all the other colours except Black, but those which are uneven and of a compound irregular and confused texture exhibit Blackness. An Example has been given, therefore, of an *Instance Migrating* towards generation in the Required Nature of Whiteness. An *Instance Migrating* towards Corruption in the same Nature is that of dissolving Froth or Snow, for they lose their Whiteness and assume the Transparency of Water in its Pure State without Air.

Nor should we by any means omit to state that under *Migrating Instances* we must comprehend not only those which *pass towards* Generation and Destruction, but those which *Pass* towards Increase or Decrease, for they too assist in the discovery of the Form, as is clear from our definition of a Form, and the *Table of Degrees.* Hence Paper, which is White when dry, is less white when moistened (from the exclusion of Air and admission of Water), and tends more to Transparency. The reason is the same as in the above *Instances.*

xxiv. In the third rank of Prerogative Instances we will class *Conspicuous Instances*, of which we spoke in our *first Vintage of the Form of Heat*, and which we are also wont to call *Coruscations*, or *Free and Predominant Instances.* They are such as show the Required Nature in its bare substantial shape, and at its height or greatest degree of Power, emancipated and free from all impediments, or at least overcoming, suppressing, and restraining them by the strength of its qualities. For since every Body is susceptible of many united Forms of Natures in the Concrete, the consequence is that they mutually deaden, depress, break, and confine each other, and the individual Forms are obscured. But there are some subjects in which the Required Nature exists in its full vigour rather than in others, either from the absence of any impediment or the Predominance of its quality. Such *Instances* are eminently *Conspicuous.* But even in these care must be taken, and the hastiness of the Understanding checked, for whatever makes a show of the Form, and forces it forward, is to be suspected, and recourse must be had to severe and diligent *Exclusion.*

For example; let Heat be the Required Nature. The Thermometer is a *Conspicuous Instance* of the Expansive Motion, which (as has been observed) constitutes the chief part of the Form of Heat. For although Flame clearly exhibit Expansion, yet from its being extinguished every moment, it does not exhibit the progress of Expansion. Boiling Water again, from its rapid conversion into Vapour, does not so well exhibit the Expansion of Water in its own shape: whilst Red Hot Iron and the like are so far from showing this progress, that, on the contrary, the Expansion itself is scarcely evident to the senses, on account of its spirit being repressed and weakened by the compact and coarse particles which subdue and restrain it. But the Thermometer strikingly exhibits the Expansion of the Air as being evident and progressive, durable and not transitory.

Take another Example. Let the Required Nature be Weight. Quicksilver is a *Conspicuous Instance* of Weight: for it is far heavier than any other substance, except Gold, which is not much heavier; and it is a better Instance than Gold for the purpose of indicating the Form of weight. For Gold is solid and Consistent, which qualities must be referred to Density, but Quicksilver is liquid, and teeming with Spirit, yet much heavier than the Diamond and other substances considered to be most solid. Whence it is shown that the Form of Gravity or weight predominates only in the quantity of Matter, and not in the Close Fitting of it.

xxv. In the fourth rank of Prerogative Instances we will class *Clandestine Instances:* which we are also wont to call *Twilight Instances.* They are as it were opposed to the *Conspicuous Instances:* for they show the Required Nature in its lowest state of efficacy, and as it were its cradle and first rudiments, making an effort, and a sort of first attempt, but concealed and subdued by a contrary Nature. Such *Instances* are, however, of great importance in discovering Forms, for as the *Conspicuous* tend easily to Differences, so do the *Clandestine* best lead to Genera; that is, to those common Natures of which the Required Natures are only the limits.

As an example: let Consistency, or that which confines itself, be the Required Nature, the opposite of which is a Liquid or Flowing State. The *Clandestine Instances* are such *as exhibit* some weak and low degree of Cons in fluids, as a Water Bubble, which is a sort of consistent and bounded pellicle formed out of the substance of the Water. So Eaves' Droppings, if there be enough Water to follow them, draw themselves out into a thin thread, not to break the continuity of the Water, but if there be not enough to follow, the Water forms itself into a round drop, which is the best Form to prevent a breach of continuity: and at the moment the thread ceases, and the Water begins to fall in drops, the thread of Water recoils upwards to avoid such a breach. Nay in Metals, which when melted, are liquid but more tenacious, the melted drops often recoil and are suspended. There is something similar in the Instance of the child's Looking-Glass, which little boys will sometimes form of spittle between rushes, and where the same pellicle of Water is observable: and still more in that other amusement of children, when they take some Water rendered a little more tenacious by Soap, and inflate it with a Pipe forming the Water into a sort of Castle of bubbles, which assumes such Consistency by the interposition of the Air as to admit of being thrown some little distance without bursting. The best example is that of Froth and Snow, which assume such Consistency as almost to admit of being cut, although composed of Air and Water, both liquids. All these circumstances clearly show that the terms Liquid and Consistent are merely vulgar Notions adapted to the sense, and that in reality all Bodies have a tendency to avoid a breach of continuity, faint and weak in Bodies composed of homogeneous parts (as is the case with Liquids), but more vivid and powerful in those composed of heterogeneous parts: because the Approach of Heterogeneous Matter binds Bodies together, whilst the Insinuation of Homogeneous Matter loosens and relaxes them.

Again, to take another Example; let the Required Nature be Attraction or the Cohesion of bodies. The most remarkable *Conspicuous Instance* with regard to its Form is the Magnet. The contrary Nature to Attraction is Non-Attraction, though in a similar substance. Thus Iron does not attract iron, Lead lead, Wood wood, nor Water water. But the *Clandestine Instance* is that of the Magnet armed with Iron, or rather that of Iron in the Magnet so armed. For its Nature is such that the Magnet when armed does not attract Iron more powerfully at any given distance, than when unarmed; but if the Iron be brought in contact with the armed Magnet, the latter will sustain a much greater weight than the simple Magnet, from the resemblance of substance in the two portions of Iron, a quality altogether *Clandestine* and hidden in the Iron, until the Magnet was introduced. It is manifest, therefore, that the Form of Cohesion is something which is vivid and robust in the Magnet, and hidden and weak in the Iron. It is to be observed also that small wooden arrows without an iron point, when discharged from large mortars, penetrate further into wooden substances (such as the ribs of Ships or the like), than the same arrows pointed with iron;[1] owing to the similarity of substance, though this quality was previously latent in the wood. Again, although in the Mass, Air does not appear to attract air, nor Water water; yet when one bubble is brought near another, they are both more readily dissolved from the tendency to Contact of the Water with the water, and the Air with the air.[2] These *Clandestine Instances* (which are, as has been observed, of the most important service) are principally to be observed in small portions of Bodies, for the larger Masses observe more Universal and general Forms, as will be mentioned in its proper place.

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[1] Query?

[2] The real cause of this Phenomenon is the attraction of the surface water in the vessel by the sides of the Bubbles. When the Bubbles approach, the sides nearest each other both tend to raise the small space of Water between them, and consequently less Water is raised by each of these nearer sides, than by the exterior part of the Bubble, and the greater Weight of the Water raised on the exterior parts pushes the Bubbles together. In the same manner a Bubble near the side of a vessel is pushed towards it; the vessel and Bubble both drawing the Water that is between them. The latter Phenomenon cannot be explained on *Bacon's* Hypothesis.

xxvi. In the fifth rank of Prerogative Instances we will class *Constitutive Instances*, which we are wont also to call *Collective Instances*. They constitute a species or lesser Form, as it were, of the Required Nature. For since the real Forms (which are always convertible with the Given Nature) lie at some depth, and are not easily discovered, the necessity of the case and the infirmity of the human Understanding require that the particular Forms, which collect certain *Groups* of Instances (but by no means all) into some Common Notion, should not be neglected, but most diligently observed. For whatever unites Nature, even imperfectly, opens the way to the discovery of the Form. The Instances, therefore, which are serviceable in this respect are of no mean power, but endowed with some degree of Prerogative.

Here, nevertheless, great Care must be taken, that after the Discovery of several of these particular Forms, and the establishing of certain Partitions or Divisions of the Required Nature derived from them, the human Understanding do not at once rest satisfied, without preparing for the investigation of the Great or leading Form, and, taking it for granted that Nature is compound and divided from its very root, despise and reject any farther union as a point of superfluous refinement, and tending to mere Abstraction.

For instance, let the Required Nature be Memory or that which Excites and Assists memory. The *Constitutive Instances* are Order or Distribution, which manifestly assists Memory ; Topics or Common-places in Artificial Memory, which may be either Places in their literal sense, as a Gate, a Corner, a Window, and the like, or familiar Persons and *Marks, or* any thing else (provided it be arranged in a de-

Memory

terminate order), as Animals, Plants, and Words, Letters, Characters, Historical Persons, and the like; of which, however, some are more convenient than others. All these Common-places materially assist Memory, and raise it far above its natural strength. Verse too is recollected and learnt more easily than Prose. From this *Group* of three Instances, Order, the Common-places of Artificial Memory, and Verses, is constituted one Species of Aid for the Memory, which may be well termed a *Separation from Infinity*. For when a man strives to recollect or recall any thing to Memory, without a preconceived notion or perception of the object of his search, he inquires about, and labours, and turns from point to point, as if involved in Infinity. But if he have any preconceived notion, this Infinity is Separated off, and the range of his Memory is brought within closer limits. In the three Instances given above, the preconceived notion is clear and determined. In the First it must be something that agrees with Order; in the Second an Image which has some relation or agreement with the fixed Common-places; in the Third Words which fall into a Verse: and thus Infinity is Divided off. Other Instances will offer another Species, namely, that whatever brings the Intellect into contact with something that strikes the Sense (the principal point of Artificial Memory), assists the Memory. Others again offer another Species, namely, whatever excites an impression by any powerful Passion, as Fear, Wonder, Shame, Delight, assists the Memory. Other Instances will afford another Species: thus those impressions remain most fixed in the memory which are taken from the Mind when clear and least occupied by preceding or succeeding notions, such as the things we learn in childhood, or imagine before sleep, and the first time of any circumstance happening. Other Instances afford the following Species: namely, that a multitude of Circumstances or Handles, assist the Memory, such as Writing in paragraphs, Reading aloud or Recitation. Lastly, other Instances afford still another Species : thus the things we anticipate, and which rouse our attention, are more easily remembered than transient events; as if you read any work twenty times over, you will not learn it by heart so readily, as if you were to read it but Ten Times, trying each time to repeat it, and when your Memory fails you looking into the book. There are, therefore, Six Lesser Forms, as it were, of things which assist the Memory: namely, 1. The Separation of Infinity. 2. The Connexion of the Mind with the Senses. 3. The Impression in strong Passion. 4. The Impression on the Mind when pure. 5. The Multitude of Handles. 6. Anticipation.

Again, for example's sake, let the Required Nature be Taste or the power of Tasting. The following *Instances* are *Constitutive :* 1. Those who do not smell, but are deprived by Nature of that sense, do not perceive or distinguish rancid or putrid food by their taste ; nor Garlic from Roses, and the like. 2. Again, those whose Nostrils are obstructed by accident (such as a cold) do not distinguish any putrid or rancid matter from anything sprinkled with Rose Water. 3. If those who suffer from a cold blow their noses violently at the very moment in which they have any thing fetid or perfumed in their Mouth, or on their palate, they Instantly have a clear perception of the fetor or perfume. These Instances afford and constitute this Species or division of Taste : namely, that it is in part nothing else than an Internal Smelling passing and descending through the upper Passages of the Nostrils to the Mouth and Palate. But, on the other hand, those whose power of Smelling is deficient, or obstructed, perceive what is Salt, Sweet, Pungent, Acid, Rough, and Bitter, and the like, as well as any one else : so that the Taste is clearly something Compounded of the Internal Smelling, and an exquisite species of Touch which *we will* not here discuss.

Again, as another example, let the Required Nature be the Communication of Quality, without Intermixture of Substance. The Instance of Light will afford or constitute one Species of Communication, Heat and the Magnet another. For the Communication of Light is Momentary and immediately arrested upon the removal of the Original Light. But Heat, and the Magnetic Force, when once transmitted to or excited in another Body, remain fixed for a considerable time after the removal of the source.

In fine, the Prerogative of *Constitutive Instances* is considerable, for they materially assist the Definitions (especially in detail) and the Divisions or Partitions of Natures, concerning which *Plato* has well said, *He who can properly define and divide is to be considered a God.*

xxvii. In the sixth rank of Prerogative Instances we will place *Similar* or *Proportionate Instances*, which we are also wont to call *Physical Parallels*, or *Resemblances*. They are such as exhibit the Resemblances and Connexion of things, not in Minor Forms (as the *Constitutive* do), but at once in the Concrete. They are therefore, as it were, the first and lowest Steps towards the union of Nature ; nor do they immediately establish any Axiom, but merely indicate and observe a certain Relation of Bodies to each other. But although they be not of much assistance in discovering Forms, yet they are of great advantage in disclosing the frame of parts of the Universe, upon whose members they practise a species of Anatomy, and thence occasionally lead us gently on to sublime and noble Axioms, especially such as relate to the construction of the World, rather than to simple Natures and Forms.

As an example ; take the following Similar Instances : a Mirror and the Eye ; the formation of the Ear, and places which return an Echo. From such Similarity, besides observing the Resemblance (which is useful for many purposes), it is easy to collect and form this Axiom. That the Organs of the Senses, and Bodies which produce reflections to the Senses, are of a similar Nature. Again, the Understanding once informed of this, rises easily to a higher and nobler Axiom; namely, that the only distinction between sensitive and inanimate Bodies, in those points in which they Agree and Sympathise, is this; in the former, Animal Spirit is added to the arrangement of the Body, in the latter it is wanting. So that there might be as many senses in Animals as there are points of Agreement with inanimate Bodies, if the Animated Body were perforated, so as to allow the Spirit to have access to the limb properly disposed for action, as a fit Organ. And, on the other hand, there are, without doubt, as many Motions in an inanimate as there are senses in the Animated Body, though the Animal Spirit be absent. There must, however, be many more Motions in inanimate Bodies than Senses in the Animated, from the small number of Organs of Sense. A very plain Example of this is afforded by pains. For, as Animals are liable to many kinds and various Descriptions of Pains (such as those of Burning, of intense Cold, of Pricking, Squeezing, Stretching, and the like), so is it most certain, that the same circumstances, as far as Motion is concerned, happen to inanimate Bodies, such as Wood or Stone, when burnt, frozen, pricked, cut, bent, bruised, and the like; although there be no Sensation, owing to the absence of Animal Spirit.

Again, wonderful as it may appear, the Roots and Branches of Trees are *Similar Instances.* For every Vegetable swells and throws out its constituent parts towards the Circumference, both upwards and downwards. And there is no difference between the Roots and Branches, except that the Root is buried in the earth, and the Branches are exposed to the Air and Sun. For if one take a young and vigorous Shoot, and bend it down to a small portion of loose earth, although it be not fixed to the ground, yet will it immediately produce a Root, and not a Branch. And, vice versâ, if earth be placed above, and so forced down with a Stone or any hard substance, as to confine the Plant and prevent its branching upwards, it will throw out Branches into the Air downwards.

The Gums of trees and most rock Gems are *Similar Instances;* for both of them are Exudations, and filtered Juices, derived in the former instance from Trees, in the latter from stones; the Brightness and Clearness of both arising from a delicate and accurate filtering. For nearly the same reason, the Hair of Animals is less beautiful and vivid in its colour, than the Plumage of most Birds, because the Juices are less delicately filtered through the skin than through the quills.

The Scrotum of Males and Matrix of Females are also *Similar Instances:* so that the noble Formation which constitutes the difference of the Sexes appears to differ only as to the one being Internal and the other External; a greater degree of Heat causing the genitals to protrude in the Male, whilst the Heat of the Female being too weak to effect this, they are retained Internally.

The Fins of Fishes, and the Feet of Quadrupeds, or the Feet and Wings of Birds, are *Similar Instances;* to which *Aristotle* adds the four folds in the motion of Serpents;[1] so that in the Formation of the Universe the Motion of animals appears to be chiefly effected by four Joints or Bendings.

The Teeth of land Animals and the Beaks of Birds are *Similar Instances*, whence it is clear, that in all perfect Animals there is a determination of some hard substance towards the Mouth.

Again the Resemblance and Conformity of Man to an inverted Plant is not absurd. For the Head is the root of the nerves and Animal Faculties, and the seminal Parts are the lowest, not including the extremities of the legs and arms. But in the Plant the root (which resembles the Head) is regularly placed in the lowest, and the seeds in the highest part.

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[1] Is not this very hasty generalization? Do Serpents move with four folds only? Observe also the Motion of Centipedes and other Insects.

Lastly, we must particularly recommend and suggest, that man's present industry in the Investigation and Compilation of Natural History be entirely changed, and directed to the reverse of the present system. For it has hitherto been active and curious in noting the variety of things, and explaining the accurate differences of Animals, Vegetables, and Minerals, most of which are the mere Sport of Nature, rather than of any real utility as concerns the Sciences. Pursuits of this nature are certainly agreeable, and sometimes of Practical Advantage, but contribute little or nothing to the thorough investigation of Nature. Our labour must, therefore, be directed towards inquiring into and observing Resemblances and Analogies, both in the whole, and its parts, for they unite Nature, and lay the foundation of the Sciences.

Here, however, a severe and rigorous Caution must be observed, that we only consider as *Similar and Proportionate Instances*, those which (as we first observed), point out Physical Resemblances: that is, real and substantial resemblances, deeply founded in Nature, and not casual and superficial, much less superstitious or curious; such as those which are constantly put forward by the writers on Natural Magic (the most idle of men, and who are scarcely fit to be named in connexion with such serious matters as we now treat of), who, with much vanity and folly, describe, and sometimes too invent, unmeaning Resemblances and Sympathies.

But leaving such to themselves, *Similar Instances* are not to be neglected, in the Greater Portions of the World's Conformation; such as Africa and the Peruvian Continent, which reaches to the Straits of Magellan; both of which possess a similar Isthmus and similar Capes, a circumstance not to be attributed to mere accident.

Again ; the New and Old World are both of them broad and expanded towards the North, and narrow and pointed towards the South.

Again ; we have very remarkable *Similar Instances* in the intense Cold, towards the Middle Regions (as it is termed) of the Air, and the violent Fires which are often found to burst from subterraneous spots, the similarity consisting in both being Ends and Extremes ; the extreme of the Nature of Cold for instance is towards the Boundary of Heaven, and that of the Nature of Heat towards the centre of the Earth, by a similar species of Opposition or Rejection of the Contrary Nature.

Lastly, in the Axioms of the Sciences, there is a *Similarity of Instances* worthy of observation. Thus the Rhetorical Trope which is called *Surprise*, is Similar to that of Music termed the *Declining of a Cadence*. Again ; the Mathematical Postulate, that *things which are equal to the same are equal to one another*, is Similar to the Form of the Syllogism in Logic, which unites things agreeing in the Middle Term. Lastly ; a certain degree of Sagacity, in collecting and searching for Physical points of Similarity, is very useful in many respects.

xxviii. In the seventh rank of *Prerogative Instances* we will place *Singular Instances*, which we are also wont to call *Irregular* or *Heteroclite* (to borrow a term from the Grammarians). They are such as exhibit bodies in the Concrete, of an apparently Extravagant and Separate nature, agreeing but little with other things of the same species. For, whilst the *Similar Instances* resemble each other, those we now speak of are only like themselves. Their use is much the same with that of *Clandestine Instances :* they bring out and unite Nature, and discover Genera or Common Natures, which must afterwards be limited by real Differences. Nor should we desist from Inquiry, until the properties and qualities of those things, which may be deemed Miracles, as it were, of Nature, be reduced to, and comprehended in, some Form or certain Law : so that all Irregularity or Singularity may be found to depend on some Common Form ; and the Miracle only consists in accurate Differences, degree, and rare coincidence, not in the Species itself. Man's Meditation proceeds no farther at present, than just to consider things of this kind, as the Secrets and vast Efforts of Nature, without an assignable Cause, and, as it were, Exceptions to General Rules.

As Examples of *Singular Instances*, we have the Sun and Moon amongst the Heavenly Bodies, the Magnet amongst Minerals ; Quicksilver amongst metals ; the Elephant amongst Quadrupeds ; the Venereal Sensation amongst the different kinds of Touch, the Scent of Sporting Dogs amongst those of Smell. The letter S too is considered by the Grammarians as sui generis, from its easily uniting with double, or triple Consonants, which no other letter will. These Instances are of great value, because they excite and keep alive Inquiry, and correct an understanding depraved by habit, and the Common course of Things.

xxix. In the Eighth rank of *Prerogative Instances*, we will place *Deviating Instances :* such as the Errors of Nature, or Strange and Monstrous Objects, in which Nature deviates and turns from her ordinary course. For the Errors of Nature differ from *Singular Instances*, in as much as the latter are the Miracles of Species, the former of Individuals. Their use is much the same, for they rectify the Understanding in opposition to habit, and reveal Common Forms. For with regard to these also, we must not desist from Inquiry, till we discern the Cause of the Deviation. The Cause does not, however, in such cases rise to a regular Form, but only to the *latent process* towards such a Form. For he who is acquainted with the Paths of Nature, will more readily observe her *Deviations*, and vice versâ, he who has learnt her *Deviations*, will be able more accurately to describe her Paths.

They differ again from *Singular Instances*, by being much more apt for Practice, and the Operative branch. For it would be very difficult to generate new Species, but less so to vary known Species, and thus produce many Rare and Unusual Results.[1] The passage from the Miracles of Nature to those of Art is easy; for if Nature be once seized in her variations, and the cause be manifest, it will be easy to lead her by Art to such deviation as she was at first led to by Chance; and not only to that but others, since Deviations on the one side lead and open the way to others in every direction. Of this we do not require any Examples, since they are so abundant. For a Compilation, or particular Natural History, must be made of all Monsters and Prodigious Births of Nature; of every thing, in short, which is New, Rare, and Unusual in Nature. This should be done with a rigorous selection, so as to be worthy of credit. Those are most to be suspected which depend upon Superstition, as the Prodigies of *Livy*, and those perhaps, but little less, which are found in the works of Writers on Natural Magic, or even Alchymy, and the like, for such men, as it were, are the very suitors and lovers of fables; but our instances should be derived from some grave and credible History, and faithful narration.

XXX. In the Ninth rank of *Prerogative Instances* we will place *Bordering Instances*, which we are also wont to term *Participants*. They are such as exhibit those species of Bodies which appear to be composed of two species, or to be the *Rudiments* between the one and the other. They may well be classed with the *Singular* or *Heteroclite*

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[1] This is well illustrated in Plants, for the Gardener can produce endless varieties of any known Species, but can never produce a new Species *itself*.

Instances: for in the whole system of things, they are Rare and Extraordinary. Yet from their dignity they must be treated of and classed separately for they point out admirably the order and constitution of things, and suggest the causes of the Number and Quality of the more Common Species in the Universe, leading the Understanding from that which is, to that which is possible.

We have Examples of them in Moss, which is something between Putrescence and a Plant; in some Comets, which hold a place between Stars and ignited Meteors; in flying Fishes, between Fishes and Birds; and in Bats, between Birds and Quadrupeds.[1] Again,

Simia quam similis turpissima bestia nobis.

We have also Biformed Fœtus, mingled species, and the like.

XXXI. In the Tenth rank of *Prerogative Instances*, we will place the *Instances* of *Power*, or the *Fasces* (to borrow a term from the Insignia of Empire), which we are also wont to call the *Wit* or *Hands of Man*. These are such Works as are most noble and perfect, and, as it were, the Masterpieces in every Art. For since our principal object is to make Nature subservient to the state and wants of man, it becomes us well to note and enumerate the Works, which have long since been in the power of Man, especially those which are most polished and perfect; because the passage from these, to New and hitherto undiscovered works, is more easy and feasible. For if any one, after an attentive contemplation of such works as are extant, be willing to push forward in his design with alacrity and vigour, he will undoubtedly either advance them, or turn them to something within their immediate reach, or even apply and transfer them to some ~~more~~ noble purpose.

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[1] There is, however, no real approximation to Birds in either the flying Fish or Bat, any more than a Man approximates to a Fish because he can swim. The wings of the flying Fish and Bat are mere expansions of Skin, bearing no resemblance whatever to those of Birds.

Nor is this all: for as the Understanding is elevated and raised by Rare and unusual Works of Nature, to investigate and discover the Forms which include them also; so is the same effect frequently produced by the excellent and wonderful Works of Art: and even to a greater degree, because, the Mode of effecting and constructing the Miracles of Art is generally plain; whilst that of effecting the Miracles of Nature is more obscure. Great care, however, must be taken, that they do not depress the Understanding, and fix it as it were to earth.

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For there is some Danger, lest the Understanding should be astonished and chained down, and as it were bewitched, by such Works of Art, as appear to be the very Summit and Pinnacle of human industry, so as not to become familiar with them, but rather to suppose, that nothing of the kind can be accomplished, unless the same means be employed, with perhaps a little more diligence, and more accurate preparation.

Now, on the Contrary, it may be stated as a fact, that the ways and means hitherto discovered and observed, of effecting any Matter or Work, are for the most part of little value, and that all really efficient power depends, and is really to be deduced from the sources of Forms, none of which have yet been discovered.

Thus (as we have before observed), had any one meditated on balistic Machines, and Battering Rams, as they were used by the Ancients, whatever application he might have exerted, and though he might have consumed a whole life in the pursuit, yet would he never have hit upon the Invention of Flaming Engines, acting by means of Gunpowder: nor would any person, who had made woollen Manufactories and Cotton the subject of his observation and reflection, have ever discovered thereby the nature of the Silk-worm or of Silk.

Hence all the most Noble Discoveries have (if you observe) come to light, not by any gradual improvement and Extension of the arts, but merely by Chance; whilst nothing imitates or anticipates Chance (which is wont to act at intervals of ages) but the Invention of Forms.

There is no necessity for adducing any particular Examples of these Instances, since they are abundant. The plan to be pursued is this; all the Mechanical, and even the Liberal Arts (as far as they are Practical), should be visited and thoroughly examined, and thence there should be formed a Compilation or Particular History, of the Great Masterpieces, or most finished Works in each, as well as of the Mode of carrying them into effect.

Nor do we confine the Diligence to be used in such a Compilation to the Leading Works and Secrets only of every Art, and such as excite wonder; for Wonder is engendered by Rarity, since that which is Rare, although it be compounded of Ordinary Natures, always begets Wonder.

On the contrary, that which is really Wonderful, from some specific difference distinguishing it from other species, is carelessly observed, if it be but familiar. Yet the *Singular Instances* of Art should be observed no less than those of Nature, which we have before spoken of: and, as in the latter we have classed the Sun, the Moon, the Magnet, and the like, all of them most familiar to us, but yet in their Nature singular, so should we proceed with the *Singular Instances* of Art.

For Example; Paper, a very common substance, is a *Singular* Instance of Art. For if you consider the subject attentively, you will find that Artificial Substances are either Woven by straight and transverse lines, as Silk, Woollen, or Linen Cloth, and the like; or coagulated from concrete juices, such as Brick, Earthenware, Glass, Enamel, Porcelain, and the like, which admit of a polish if they be compact, but if not, become hard without being polished ; all which latter substances are brittle, and not adherent or tenacious. On the contrary, Paper is a tenacious substance, which can be cut and torn, so as to resemble and almost rival the Skin of any Animal, or the Leaf of Vegetables, and the like works of Nature ; being neither brittle like Glass, nor woven like Cloth, but having fibres and not distinct threads, just as Natural Substances, so that scarcely any thing similar can be found amongst Artificial Substances, and it is absolutely *Singular*. And in Artificial works we should certainly prefer those which approach the nearest to an imitation of Nature, or on the other hand, powerfully govern and change her course.

Again in these instances which we term the *Wit and Hands of Man*, Charms and Conjuring should not be altogether despised, for although mere amusements, and of little use, yet they may afford considerable information.

Lastly, Superstition, and Magic (in its common acceptation), are not to be entirely omitted ; for although they be overwhelmed by a mass of Lies and fables, yet some investigation should be made, to see if there be really any latent Natural operation in them ; as in Fascination, and the Fortifying of the Imagination, the Sympathy of distant objects, the Transmission of Impressions from Spirit to Spirit no less than from Body to Body, and the like.

xxxii. From the foregoing remarks, it is clear that the five last species of Instances (*the Similar*, *Singular*, *Deviating*, *and Bordering Instances*, *and those of Power*) should not be reserved for the investigation of any given Nature, as the preceding and many of the succeeding Instances must, but a Collection of them should be made at once, in the style of a particular History ; so that they may arrange the *matter which* enters the Understanding, and correct its depraved habit, for it is necessarily imbued, corrupted, perverted, and distorted by daily and habitual impressions.

They are to be used, therefore, as a Preparative, for the purpose of rectifying and purifying the Understanding, for whatever withdraws it from habit, levels and planes down its surface for the reception of the dry and pure Light of true Notions.

These Instances, moreover, level and prepare the way for the Operative Branch, as we will mention in its proper place when speaking of the *Practical Deductions.*

xxxiii. In the Eleventh Rank of *Prerogative Instances,* we will place *Accompanying and Hostile Instances.* These are such as exhibit any Body or Concrete, where the Required Nature is constantly found, as an inseparable Companion, or, on the contrary, where the Required Nature is constantly avoided, and excluded from *Attendance,* as an Enemy. From these Instances may be formed certain and Universal Propositions, either *Affirmative* or *Negative;* the Subject of which will be the Concrete Body, and the Predicate the Required Nature. For Particular Propositions are by no means *Fixed,* when the Required Nature is found to fluctuate and change in the Concrete, either Approaching and Acquired, or Receding and Laid aside. Hence Particular Propositions have no great *Prerogative,* except in the Case of *Migration,* of which we have spoken above. Yet such Particular Propositions are of great use, when compared with the Universal, as will be mentioned in its proper place. Nor do we require absolute Affirmation or Negation, even in Universal Propositions, for if the Exceptions be singular or rare, it is sufficient for our purpose.

The use of *Accompanying Instances* is to narrow the *Affirmative* of Form. For as it is narrowed by the *Migrating Instances,* where the Form must necessarily be something communicated or destroyed by the Act of *Migration,* so it is narrowed by *Accompanying Instances,* where the Form must necessarily be something which enters into the Concretion of the body, or, on the contrary, is repugnant to it, and one who is well acquainted with the Constitution or Formation of the body, will not be far from bringing to light the Form of the Required Nature.

For example : let the Required Nature be Heat. Flame is an *Accompanying Instance.* For in Water, Air, Stone, Metal, and many other substances, Heat is variable, and can approach or retire, But all flame is hot, so that Heat always accompanies the concretion of Flame. We have no *Hostile Instance* of Heat. For the senses are unacquainted with the interior of the Earth, and there is no Concretion of any known Body which is not susceptible of Heat.

Again, let solidity be the Required Nature. Air is an *Hostile Instance.* For Metals may be liquid or solid, so may Glass ; even Water may become solid by congelation, but Air cannot become solid or lose its fluidity.

With regard to these *Instances* of *fixed Propositions*, there are two Points to be observed, which are of importance. First, that if there be no Universal *Affirmative* or *Negative*, it be carefully noted as Not-Existing. Thus, in Heat, we have observed that there exists no Universal Negative, in such Substances at least as have come to our knowledge. Again, if the Required Nature be *Eternity* or *Incorruptibility*, we have no Universal Affirmative within our sphere, for these qualities cannot be predicated of any bodies below the Heavens, or above the interior of the Earth. Secondly, to our General Propositions as to any Concrete, whether Affirmative or Negative, we should subjoin the Concretes which appear to approach nearest to the Non-Existing substances ; such as the most gentle or least burning Flames in Heat, or Gold in Incorruptibility since it approaches nearest to it. For they all serve to show the limit of Existence and Non-Existence, and Circumscribe

Forms, so that they cannot wander beyond the conditions of Matter.

xxxiv. In the Twelfth rank of *Prerogative Instances*, we will class those *Subjunctive Instances*, of which we spoke in the last Aphorism, and which we are also wont to call *Instances of Extremity* or *Limits;* for they are not only serviceable when subjoined to Fixed Propositions, but also of themselves and from their own nature. They indicate with sufficient precision the real Divisions of Nature, and Measures of things, and the '*How far*' Nature effects or allows of any thing, and her Passage thence to something else. Such are Gold in Weight, Iron in Hardness, the Whale in the Size of Animals, the Dog in Smell, the Flame of Gunpowder in rapid Expansion, and others of a like nature. Nor are we to pass over the Extremes in defect as well as in abundance, as Spirits of wine in Weight, the Touchstone in Softness, the Worms upon the skin in the Size of Animals, and the like.

xxxv. In the Thirteenth rank of *Prerogative Instances*, we will place those of *Alliance* or *Union*. They are such as mingle and unite Natures held to be Heterogeneous, and observed and marked as such in received classifications.

These *Instances* show that the operation and effect, which is considered peculiar to some one of such Heterogeneous natures, may also be attributed to another Nature styled Heterogeneous; so as to prove that the difference of the Natures is not real nor essential, but a mere Modification of a common Nature. They are very serviceable, therefore, in elevating and carrying on the Mind, from Differences to Genera, and in removing those phantoms and images of things, which meet it in disguise in Concrete substances.

For example; let the *Required Nature* be Heat. The classification of Heat into three kinds, that of the Celestial Bodies, that of Animals, and that of Fire, appears to be settled and admitted: and these kinds of Heat, especially one of them compared with the other two, are supposed to be different, and clearly heterogeneous in their essence and species, or specific nature; Since the Heat of the Heavenly bodies and of Animals generates and cherishes, whilst that of Fire corrupts and destroys. We have an *Instance of Alliance* then in a very common Experiment, that of a vine branch admitted into a building where there is a constant fire, by which the grapes ripen a whole month sooner than in the air; So that fruit upon the tree can be ripened by fire, although this appear the peculiar effect of the Sun. From this beginning, therefore, the Understanding rejects all essential Difference, and easily ascends to the investigation of the real Differences between the Heat of the Sun and that of Fire, by which their operation is rendered dissimilar, although they partake of a common Nature.

These Differences will be found to be four in number. 1. The Heat of the Sun is much milder and gentler in degree than that of Fire. 2. It is much more moist in quality, especially as it is transmitted to us through the Air. 3. Which is the Chief Point, it is very unequal, advancing and increased at one time, retiring and diminished at another; which mainly contributes to the Generation of bodies. For *Aristotle* rightly asserted, that the principal cause of Generation and corruption on the surface of the Earth, was the oblique path of the Sun in the Zodiac, whence its Heat becomes very unequal, partly from the alternation of Night and Day, partly from the succession of Summer and Winter. Yet must he immediately corrupt and pervert his discovery, by dictating to Nature according to his habit, and Dogmatically assigning the cause of Generation to the Approach of the Sun, and that of Corruption to its Retreat; whilst in fact each circumstance indifferently and not respectively contributes both to Generation and Corruption; for unequal Heat tends to Generate and Corrupt, as equable heat does to Preserve.

4. The Fourth Difference between the Heat of the Sun and Fire is of great consequence; namely, that the Sun, gradually, and for a length of time, insinuates its effects, whilst those of Fire (urged by the impatience of man) are brought to a termination in a shorter space of time. But if any one were to pay attention to the Tempering of Fire, and reducing it to a more moderate and gentle degree (which may be done in various ways), and then were to sprinkle and mix a degree of humidity with it, and above all were to imitate the Sun in its inequality, and lastly were patiently to suffer some delay (not such, however, as is proportioned to the effects of the Sun, but more than men usually admit of in those of Fire), he would soon banish the notion of any Difference, and would attempt, or equal, or perhaps sometimes surpass the effect of the Sun, by the Heat of Fire. A like *Instance of Alliance*, is that of reviving Butterflies, benumbed and nearly dead from cold, by the gentle warmth of Fire, so that Fire is no less able to revive Animals than to ripen Vegetables. We may also mention the celebrated Invention of *Fracastorius*, of applying a Pan considerably heated to the head in desperate cases of apoplexy, which clearly expands the animal spirits, when compressed and almost extinguished by the humours and obstructions of the Brain, and excites them to action, as the Fire would operate on Water or Air, and in the result produces life. Eggs are sometimes hatched by the Heat of Fire, an exact imitation of Animal Heat; and there are many instances of the like nature, so that no one can doubt that the Heat of Fire, in many cases, can be modified till it resemble that of the Heavenly Bodies and of Animals.

Again, let the Required Natures be Motion and Rest. There appears to be a settled classification grounded on the deepest Philosophy, that Natural bodies either revolve, move in a straight line, or stand still and rest. For there is either Motion without limit, or Continuance within a certain limit, or a Translation towards a certain limit. The eternal motion of Revolution appears peculiar to the Heavenly bodies, Rest to this our Globe, and the other bodies (Heavy and Light, as they are termed, that is to say, placed out of their natural position) are borne in a straight line to Masses or aggregates which resemble them, the Light towards the Heaven, the Heavy towards the Earth: and all this is very fine language.

But we have an *Instance of Alliance* in low Comets, which revolve though far below the Heavens; And the fiction of *Aristotle*, of the Comet being fixed to or necessarily following some Star, has been long since exploded; not only because it is improbable in itself, but from the evident fact of the discursive and irregular motion of Comets, through various parts of the Heavens.

Another *Instance of Alliance* is that of the Motion of Air, which appears to revolve from East to West within the Tropics, where the Circles of Revolution are the greatest.

The Flow and Ebb of the Sea would perhaps be another *Instance*, if the water were once found to have a motion of Revolution, though slow and hardly perceptible, from East to West, subject however to a reaction twice a day. If this be so, it is clear that the Motion of Revolution is not confined to the Celestial bodies, but is shared also by Air and Water.

Again; the supposed peculiar disposition of Light Bodies to rise is rather shaken; and here we may find an *Instance of Alliance* in a water Bubble. For if air be placed under water, it rises rapidly towards the surface, by that *Striking Motion* (as Democritus terms it) with which the descending water strikes the air, and raises it; not by any struggle or effort of the air itself: and when it has reached the surface of the Water, it is prevented from ascending any further, by the slight resistance it meets with in the Water, which *does not* allow an immediate separation of its parts, so that the tendency of the Air to rise must be very slight.

Again; let the Required Nature be Weight. It is certainly a received classification; that Dense and Solid bodies are borne towards the centre of the Earth, and Rare and Light bodies to the circumference of the Heavens, as their appropriate places. As far as relates to places (though these things have much weight in the Schools), the notion of there being any determinate Place is absurd and puerile. Philosophers trifle therefore when they tell you, that if the Earth were perforated, heavy bodies would stop on their arrival at the Centre. This Centre would indeed be an efficacious Nothing or Mathematical Point could it affect bodies or be sought by them, for a Body is not acted upon except by a body.[1] In fact, this tendency to Ascend and Descend is either in the Conformation of the moving body, or in its harmony and Sympathy with another body. But if any Dense and Solid body be found, which does not however tend towards the Earth, the Classification is at an end. Now if we allow of *Gilbert's* opinion, that the Magnetic power of the Earth, in attracting heavy bodies, is not extended beyond the limit of its peculiar Virtue (which operates always at a fixed distance and no further),[2] and this be proved by some Instance, such an Instance will be one of *Alliance* in our present subject. The nearest approach to it is that of Waterspouts, frequently seen by persons navigating the Atlantic towards either of the Indies. For the force and mass of the water suddenly effused by Waterspouts appears to be so considerable that the Water must have been Collected previously, and have remained fixed where it was formed, until it was afterwards forced down by some violent cause, rather than made to fall by the natural Motion of gravity: so that it may be conjectured, that a dense and compact mass, at a great distance from the Earth, may be suspended as the Earth itself is, and would not fall, unless forced down. We do not, however, affirm this as certain. In the mean while, both in this respect and many others, it will readily be seen how deficient we are in Natural History, since we are forced to have recourse to Suppositions for Examples, instead of ascertained Instances.

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[1] But see *Bacon's* own corollary at the end of the *Instances of Divorce*, Aphorism xxxvii.

[2] Since *Newton's* discovery of the law of gravitation we find that the attractive force of the earth must extend to an infinite distance. *Bacon* himself alludes to the operation of this attractive force at great *distances* in the *Instances of the Rod*, Aphorism xlv.

Again; let the *Required Nature* be the Discursive power of the Mind. The classification of Human Reason, and Animal Instinct, appears to be perfectly correct. Yet there are some instances of the actions of Brutes which seem to show that they too can syllogize. Thus it is related, that a Crow, which had nearly perished from thirst in a great drought, saw some water in the hollow trunk of a tree, but as it was too narrow for him to get into it, he continued to throw in pebbles, which made the water rise till he could drink, and it afterwards became a Proverb.

Again; let the Required Nature be Vision. The classification appears real and certain, which considers Light as that which is originally Visible, and confers the power of seeing; and Colour as being secondarily Visible, and not capable of being seen without light, so as to appear a mere image or modification of Light. Yet there are *Instances of Alliance* in each respect; as in Snow when in great quantities, and in the Flame of sulphur; the one being a Colour originally and in itself light, the other a Light verging towards colour.[1]

xxxvi. In the fourteenth rank of Prerogative Instances, we will place the *Instances of the Cross*, borrowing our metaphor from the *Crosses* erected where Two roads meet, to point out the different directions. We are wont also to call them *Decisive* and *Judicial Instances*, and in some Cases *Instances of the Oracle*, and of *Command*. Their nature is as follows. When in Investigating any Nature the Understanding is, as it were, Balanced, and uncertain to which of two or more Natures the Cause of the Required Nature should be assigned, on account of the frequent and usual concurrence of several Natures; the *Instances of the Cross* show that the union of one Nature with the Required Nature is firm and indissoluble, whilst that of the other is unsteady and separable; by which means the question is decided, and the First is received as the Cause, whilst the other is dismissed and rejected. Such Instances therefore afford great light, and are of great weight, so that the Course of Interpretation sometimes terminates and is completed in them. Sometimes, however, they are found amongst the *Instances* already observed, but they are generally New, being expressly and Purposely sought for and applied, and brought to light only by attentive and active Diligence.

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[1] *Snow* reflects light, but is not a source of light.

For example; let the Required Nature be the Flow and Ebb of the Sea, which is repeated twice a day, at intervals of Six hours between each advance and retreat, with some little difference, agreeing with the Motion of the Moon. We have here the following Cross-ways.

This Motion must be occasioned either by the Advancing and the Retiring of the Sea, like Water shaken in a basin, which leaves one side while it washes the other; or by the Rising of the Sea from the bottom, and its again subsiding like boiling Water. But a doubt arises, to which of these Causes we should assign the flow and Ebb. If the first Assertion be admitted, it follows, that when there is a Flood on one side, there must at the same time be an Ebb on another, and the Question therefore is reduced to this. Now *Acosta*, and some others, after a diligent Inquiry, have observed that the Flood Tide takes place on the coast of *Florida*, and the opposite coasts of *Spain* and *Africa*, at the same time, as does also the Ebb; and that there is not, on the contrary, a flood tide at *Florida* when there is an Ebb on the coasts of *Spain* and *Africa*. Yet if one consider the subject attentively, this does not prove the necessity of a Rising Motion, nor refute the notion of a progressive Motion. For the Motion may be progressive, and yet inundate the opposite shores of a Channel at the same time; as if the Waters be forced and driven together from some other quarter for instance, which takes place in Rivers, for they flow and ebb towards each bank at the same time, yet their Motion is clearly Progressive, being that of the Waters from the Sea entering their mouths. So it may happen, that the Waters coming in a vast body from the *Eastern Indian Ocean* are driven together, and forced into the Channel of the *Atlantic*, and therefore inundate both coasts at once. We must inquire, therefore, if there be any other Channel, by which the Waters can, at the same time, sink and ebb: and the Southern Ocean at once suggests itself, which is not less than the *Atlantic*, but rather broader, and more extensive than is requisite for this effect.

We at length arrive, then, at an *Instance of the Cross*, which is this. If it be positively discovered, that when the Flood sets in towards the opposite coasts of *Florida* and *Spain* in the *Atlantic*, there is at the same time a Flood tide on the coasts of *Peru*, and the back part of *China* in the Southern Ocean, then assuredly, from this *Decisive Instance*, we must reject the Assertion, that the Flood and Ebb of the Sea, about which we inquire, takes place by Progressive Motion; for no other Sea or place is left where there can be an Ebb. But this may most easily be learnt, by inquiring of the Inhabitants of *Panama* and *Lima* (where the two Oceans are separated by a narrow Isthmus), whether the Flood and Ebb takes place on the opposite sides of the isthmus at the same time, or the reverse. This Decision or Rejection appears certain, if it be granted that the Earth is fixed: but if the Earth revolves, it may perhaps happen, that from the unequal revolution (as regards velocity) of the Earth, and the Waters of the Sea, there may be a violent Forcing of the Waters into a Mass, forming the Flood, and a subsequent Relaxation of them (when they can no longer bear the accumulation), forming the Ebb. A separate inquiry must be made into this. Even with this Hypothesis, however, it remains equally true, that there must be an Ebb somewhere, at the same time that there is a Flood in another quarter.

Again, let the Required Nature be the Latter of the two motions we have supposed: namely, that of a Rising and Subsiding Motion, if it should happen that upon diligent examination the Progressive Motion be rejected. We have then Three ways before us, with regard to this Nature. The Motion, by which the Waters raise themselves, and again fall back, in the Floods and Ebbs, without the addition of any other Water rolled towards them, must take place in one of the three following ways. Either the Supply of Water emanates from the interior of the Earth, and returns back again; or there is really no greater Quantity of Water, but the Same Water (without any augmentation of its Quantity) is extended or rarefied, so as to occupy a greater space and dimension, and again contracts itself; or there is neither an additional Supply nor any Extension, but the same Waters (with regard to Quantity, Density, or Rarity) raise themselves and fall from Sympathy, by some Magnetic power attracting and calling them up as it were from above. Let us then (passing over the first two Motions) reduce the Investigation to the last; and inquire, if there be any such Elevation of the water, by Sympathy or a Magnetic force. And it is evident, in the first place, that *the* whole mass of Water being placed in the Trench or

Cavity of the Sea cannot be raised at once, because there would not be enough to cover the bottom, so that if there be any tendency of this kind, in the water to raise itself, yet it would be interrupted and checked by the Cohesion of things, or (as the common expression is) that there may be no Vacuum. The Water, therefore, must rise on one side, and for that reason be diminished, and ebb on another. But it will again necessarily follow, that the Magnetic power, not being able to operate on the Whole, operates most intensely on the Centre, so as to raise the Waters there, which, when thus raised successively, desert and abandon the sides.

We at length arrive then at an *Instance of the Cross*, which is this: If it be found, that during the Ebb the surface of the Waters at Sea is more curved and round, from the Waters rising in the middle, and sinking at the sides or coast, and if, during the Flood, it be more even and level, from the Waters returning to their former position, then assuredly, by this *Decisive Instance*, the Raising of them by a Magnetic force can be admitted; if otherwise, it must be entirely rejected. It is not difficult to make the experiment (by sounding in Straits), whether the Sea be deeper towards the middle in Ebbs, than in Floods. But it must be observed, if this be the case, that (contrary to common opinion) the Waters rise in Ebbs, and only return to their former position in Floods, so as to bathe and inundate the coast.

Again, let the Required Nature be the spontaneous Motion of Revolution, and particularly, whether the Diurnal Motion, by which the Sun and Stars appear to us to rise and set, be a real Motion of Revolution in the Heavenly Bodies, or only Apparent in them, and Real in the Earth. There may be an *Instance of the Cross* of the following nature. If there be discovered any Motion in the Ocean from *East to West*, though very languid and weak, and if the same Motion be discovered rather more swift in the Air (particularly within the Tropics, where it is more perceptible from the Circles being greater), If it be discovered also in the low Comets, and be already quick and powerful in them ; if it be found also in the Planets, but so tempered and regulated as to be slower in those nearest the Earth, and quicker in those at the greatest distance, being quickest of all in the Heavens, then the Diurnal Motion should certainly be considered as real in the Heavens, and that of the Earth must be rejected ; for it will be evident that the Motion from East to West is part of the system of the World and Universal ; since it is most rapid in the Height of the Heavens, and gradually grows weaker, till it stops and is extinguished in Rest at the Earth.

Again, let the Required Nature be that other Motion of Revolution, so celebrated amongst Astronomers, which is contrary to the Diurnal, namely, from West to East, and which the Ancient Astronomers assign to the Planets, and even to the Starry Sphere, but *Copernicus* and his Followers to the Earth also, and let it be examined whether any such Motion be found in Nature, or it be rather a fiction and hypothesis for Abridging and Facilitating Calculation, and for Promoting that fine notion of Effecting the Heavenly Motions by perfect Circles. For there is nothing which proves such a Motion in Heavenly Objects to be true and real, either in a Planet's not returning in its Diurnal Motion to the same point of the starry Sphere, or in the Pole of the Zodiac being different from that of the World, which two circumstances have occasioned this notion. For the first Phenomenon is well accounted for by the spheres Overtaking or Falling behind each other, and the second by Spiral Lines, so that the Inaccuracy of the Return, and Declination to the Tropics may be rather Modifications of the one Diurnal Motion than contrary Motions, or about different Poles. And it is most certain, if we consider ourselves for a moment as part of the Vulgar (setting aside the fictions of Astronomers and the School, who are wont undeservedly to attack the Senses in many respects, and to affect obscurity), that the Apparent Motion is such as we have said, a model of which we have sometimes caused to be represented by wires in a sort of Machine.

We may take the following Instances of the Cross upon this subject. If it be found in any History, worthy of credit, that there has existed any Comet, high or low, which has not revolved in manifest Harmony (however irregularly) with the Diurnal Motion, then we may decide so far as to allow such a Motion to be possible in Nature. But if nothing of the sort be found, it must be suspected, and recourse must be had to other *Instances of the Cross.*

Again, let the Required Nature be Weight or Gravity. Heavy and Ponderous Bodies must, either of their own Nature, tend towards the Centre of the Earth, by their peculiar Formation; or must be attracted, and hurried, by the Corporeal Mass of the Earth itself, as being an Assemblage of Similar Bodies, and be drawn to it by Sympathy.[1] But if the latter be the cause, it follows that the nearer bodies approach to the Earth, the more powerfully and rapidly they must be borne towards it, and the further they are distant the more faintly and slowly (as is the case in Magnetic Attractions), and that this must happen within a given distance, so that if they be separated at such a distance from the Earth that the power of the Earth cannot act upon them, they will remain suspended like the Earth, and not fall at all.

The following *Instance of the Cross* may be adopted.

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[1] A close approximation to the truth and the experiment pointed out is very ingenious; indeed the Oscillations of the Pendulum, moving by its own Weight, have since been used as the most delicate tests of *the variation of Gravity* from the Equator towards the Poles.

Take a Clock moved by leaden Weights, and another by a spring, and let them be set well together, so that one be neither quicker nor slower than the other; then let the Clock moved by Weights be placed on the top of a very high Church, and the other be kept below, and let it be well observed, if the former move slower than it did; from the diminished power of the Weights. Let the same Experiment be made at the bottom of Mines worked to a considerable depth, in order to see whether the Clock move more quickly from the increased power of the Weights.[1] But if this Power be found to diminish at a height, and to increase in subterraneous places, the Attraction of the Corporeal Mass of the Earth may be taken as the Cause of Weight.

Again, let the Required Nature be the Polarity of the steel Needle, when touched with the Magnet. We have these two Ways with regard to this Nature. Either the Touch of the Magnet must communicate Polarity to the steel towards the North and South, or else it may only excite and prepare it, whilst the actual Motion is occasioned by the presence of the Earth, which *Gilbert* considers to be the case, and endeavours to prove with so much labour. The particulars he has inquired into with such ingenious zeal amount to this: 1. An iron Bolt placed for a long time towards the North and South acquires Polarity from this habit, without the Touch of the Magnet; as if the Earth itself operating but weakly from its distance (for the surface or outer crust of the Earth does not, in his opinion, possess the Magnetic Power), yet, by long continued motion, could supply the place of the Magnet, excite the Iron, and convert and change it when excited. 2. Iron, at a Red or White Heat, when quenched in a direction parallel to the North and South, also acquires Polarity without the Touch of the Magnet; as if the parts of Iron being put in Motion by Ignition, and afterwards recovering themselves, were at the moment of being quenched more susceptible and sensitive of the Power emanating from the Earth, than at other times, and therefore, as it were, excited. But these points, though well observed, do not completely prove his assertion.

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[1] The attractive Power to the centre is on the whole diminished in *Mines, because the* Earth above attracts in the contrary direction.

An *Instance of the Cross* on this point might be as follows. Let a Small Magnetic Globe be taken, and its Poles marked, and placed towards the East and West, not towards the North and South, and let it continue thus. Then let an Untouched Needle be placed over it, and suffered to remain so for six or seven days. Now the Needle (for this is not disputed), whilst it remains over the Magnet, will leave the Poles of the world, and turn to those of the Magnet, and, therefore as long as it remains in the above position will turn to the East and West. But if the Needle, when removed from the Magnet, and placed upon a pivot, be found immediately to turn to the North and South, or even by degrees to return thither, then the presence of the Earth must be considered as the Cause, but if it remains turned as at first towards the East and West, or lose its Polarity, then that Cause must be suspected, and farther inquiry made.

Again, let the required Nature be the Corporeal Substance of the Moon, whether it be Rare, Fiery, and Aërial (as most of the ancient Philosophers have thought), or solid and Dense (as *Gilbert* and many of the Moderns, with some of the Ancients, hold).[1] The Reasons for this latter Opinion are grounded chiefly upon this, that the Moon reflects the Sun's rays, and that Light does not appear capable of being Reflected, except by Solids. The *Instances of the Cross* will, therefore (if any), be such as to exhibit Reflection by a rare Body, such as Flame, if it be but sufficiently dense. Now certainly one of the Reasons of Twilight is the Reflection [1] of the rays of the Sun by the upper part of the Atmosphere. We see the Sun's rays also reflected on fine evenings, by streaks of moist clouds, with a splendour not less, but perhaps more bright and glorious, than that reflected from the Body of the Moon, and yet it is not clear that those clouds have formed into a dense Body of Water. We see also that the dark Air, behind the windows at night, reflects the light of a Candle in the same manner as a dense Body would do.[2] The Experiment should also be made of causing the Sun's rays to fall through a hole upon some dark and bluish Flame. The unconfined rays of the Sun, when falling on faint Flames, do certainly appear to deaden them, and render them more like white Smoke than Flames. These are the only instances which occur at present of the Nature of those of the *Cross*, and better perhaps can be found. But it must always be observed, that Reflection is not to be expected from Flame, unless it be of some depth, for otherwise it becomes nearly Transparent. This at least may be considered certain, that Light is always either received and transmitted or reflected by an even Surface.

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[1] A sufficient Proof of its necessary solidity is now afforded by the *attraction of the Sea,* and the Moon's motion round the Earth.

Again, let the Required Nature be the Motion of Projectiles (such as Darts, Arrows, and Balls) through the Air. The School, in its usual manner, treats this very carelessly, considering it enough to distinguish it by the name of violent Motion, from that which they term Natural, and as far as regards the first percussion or impulse satisfies itself by its axiom, *that two Bodies cannot exist in one place*,

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[1] Rather the Refraction—the Sky or Air, however, *reflects* the blue rays of Light.

[2] The polished surface of the Glass causes the reflection in this case, and not the Air; and a Hat or other black Surface put behind the window in the Day Time will enable the Glass to reflect distinctly for the same reason; namely, that the reflected Rays are not mixed and confused with those transmitted from the other side of the Window.

or there would be a penetration of Dimensions. With regard to this Nature we have these two Crossways. The Motion must arise either from the Air carrying the projected Body and collecting behind it, like a stream behind Boats or the wind behind straws; or from the parts of the Body itself not supporting the impression, but pushing themselves forward in succession to ease it. *Fracastorius*, and nearly all those who have entered into any refined inquiry upon the subject, adopt the first. Nor can it be doubted, that the Air has some effect, yet the other Motion is, without doubt, real, as is clear from a vast number of Experiments. Amongst others we may take this *Instance of the Cross:* namely, that a thin Plate or Wire of Iron rather stiff, or even a Reed or pen split in two, when drawn up and bent between the finger and thumb, will leap forward. For it is clear, that this cannot be attributed to the Air's being collected behind the Body, because the source of Motion is in the centre of the Plate or Pen, and not in its Extremities.

Again, let the Required Nature be the rapid and powerful Motion of the Explosion of Gunpowder, by which such vast masses are upheaved, and such weights discharged as we observe in large Mines and Mortars; there are two Cross-ways before us, with regard to this Nature. This Motion is excited, either by the mere Effort of the Body expanding itself when inflamed, or by the assisting effort of the Crude Spirit, which escapes rapidly from Fire, and bursts violently from the surrounding flame as from a Prison. The School, however, and common Opinion, only consider the first Effort. For men think that they are great philosophers, when they assert that Flame, from the Form of the Element, is endowed with a kind of necessity of occupying a greater space, than the same Body had occupied when in the Form of Powder, and that thence proceeds the Motion in question. In the mean time they do not observ that although this may be true, on the supposition of Fl being generated, yet the generation may be impeded by a weight of sufficient Force to compress and suffocate it; so that no such Necessity exists as they assert. They are right, indeed, in imagining that the Expansion, and the consequent Emission or removal of the opposing Body, is necessary if Flame be once generated; but such a Necessity is avoided, if the solid opposing Mass suppress the Flame before it be generated. And we in fact see that Flame, especially at the moment of its generation, is mild and gentle, and requires a Hollow space where it can play and try its force. The great violence of the effect, therefore, cannot be attributed to this cause: but the truth is, that the generation of these exploding Flames and fiery blasts arises from the conflict of two Bodies of a decidedly opposite Nature; the one very inflammable, as is the Sulphur, the other having an antipathy to Flame, namely, the Crude Spirit of the Nitre: so that an extraordinary Conflict takes place, whilst the Sulphur is becoming inflamed, as far as it can (for the third Body, the willow Charcoal merely incorporates and conveniently unites the two others), and the Spirit of Nitre is escaping, as far also as it can, and at the same time expanding itself (for Air, and all Crude Substances, and Water are expanded by Heat), fanning thus, in every direction, the Flame of the Sulphur by its escape and violence, just as if by invisible bellows.

Two kinds of *Instances of the Cross* might here be used: the one of very inflammable Substances, such as Sulphur and Camphire, Naphtha, and the like, and their compounds, which take fire more readily and easily than Gunpowder, if left to themselves (and this shows that the Effort to catch Fire does not of itself produce such a prodigious effect); the other of substances which avoid and repel Flame, such as all Salts. For we see that when they are cast into the Fire the Aqueous Spirit escapes with a crackling noise before *Flame* is produced, which also happens, in a less degree, in stiff Leaves; from the escape of the Aqueous part, before the Oily part has caught Fire. This is more particularly observed in Quicksilver, which is not improperly called Mineral Water; and which, without any inflammation, nearly equals the force of gunpowder, by simple Explosion and Expansion, and is said, when mixed with Gunpowder, to increase its force.

Again, let the Required Nature be the Transitory Nature of Flame, and its Momentaneous Extinction. For to us the Nature of Flame does not appear to be fixed or settled, but to be generated from moment to moment, and to be every instant extinguished; it being clear that those Flames which continue and last, do not owe their continuance to the same mass of Flame, but to a continued succession of new Flame regularly generated, and that the same identical Flame does not continue. This is easily shown by removing the food or source of the Flame, when it at once goes out. We have the two following Cross-ways with regard to this nature. This Momentary Nature either arises from the cessation of the Cause which first produced it, as in Light, Sounds, and Violent Motions, as they are termed, or Flame may be capable by its own Nature of duration, but is subjected to some violence from the contrary Natures which surround it, and is destroyed.

We may, therefore, adopt the following *Instance of the Cross.* We see to what a height the Flames rise in great Conflagrations; for as the Base of the Flame becomes more extensive, its Vertex is more lofty. It appears, then, that the commencement of the extinction takes place at the Sides, where the Flame is compressed by the Air, and is ill at ease. But the Centre of the Flame, which is untouched by the Air, and surrounded by Flame, continues the same, and is not extinguished, until compressed by degrees by the Air attacking it from the Sides. All Flame, therefore, is *Pyramidal, having its* Base near the source, an pointed from its being resisted by the Air, and not supplied from the source. On the contrary, the Smoke, which is narrow at the Base, expands in its ascent, and resembles an inverted Pyramid; because the Air admits the Smoke, but compresses the Flame; for let no one dream that the lighted Flame is Air, since they are clearly Heterogeneous.

The *Instance of the Cross* will be more accurate, if the experiment can be made by Flames of Different Colours. Take, therefore, a small metal Sconce, and place a lighted Taper in it, then put it in a basin, and pour a small quantity of Spirits of Wine round the Sconce, so as not to reach its edge, and light the Spirit. Now the Flame of the Spirit will be blue, and that of the Taper yellow; observe, therefore, whether the latter (which can easily be distinguished from the former by its Colour, for Flames do not mix immediately as Liquids do), continue Pyramidal, or tend more to a globular Figure, since there is nothing to destroy or compress it. If the latter result be observed, it must be considered as settled, that Flame continues positively the same, whilst inclosed within another Flame, and not exposed to the resisting force of the Air.

Let this suffice for the *Instances of the Cross*. We have dwelt the Longer upon them in order gradually to teach and accustom mankind to judge of Nature by these *Instances*, and Enlightening Experiments, and not by probable reasons.

xxxvii. We will treat of the *Instances of Divorce* as the Fifteenth of our *Prerogative Instances*. They indicate the Separation of Natures of the most common occurrence. They differ, however, from those subjoined to the *Accompanying Instances;* for the Instances of divorce point out the Separation of a particular Nature from some concrete substance with which it is usually found in conjunction, whilst the hostile instances point out the total Separation of one Nature from another. They differ also from the

Instances of the Cross, because they decide nothing, but only inform us that the one Nature is capable of being Separated from the other. They are of use in exposing false Forms, and dissipating hasty Theories derived from obvious facts: so that they add ballast and weight, as it were, to the Understanding.

For instance, let the Required Natures be those four which *Telesius* terms *Associates*, and of the same Family, namely, Heat, Light, Rarity, and Mobility, or promptitude to Motion; yet many *Instances of Divorce* can be discovered between them. Air is Rare and easily Moved, but neither Hot nor Light, the Moon is Light but not Hot, boiling Water is Warm but not Light, the Motion of the Needle in the Compass is swift and active, and yet its Substance is Cold, Dense, and Opaque; and there are many similar examples.

Again, let the Required Natures be Corporeal Nature and Natural Action. The latter appears incapable of subsisting without some Body, yet may we, perhaps, even here find an *Instance of Divorce*, as in the Magnetic Motion, which draws the Iron to the Magnet, and Heavy bodies to the globe of the Earth; to which we may add other Actions which Operate at a Distance. For such action takes place in Time, by distinct Moments, not in an Instant; and in Space by regular degrees and distances. There is, therefore, some one Moment of Time and some Interval of Space, in which the Power or Action is suspended betwixt the two Bodies creating the Motion. Our Consideration then is reduced to this, whether the Bodies which are the Extremes of Motion prepare or alter the Intermediate Bodies, so that the Power advances from one Extreme to the other by succession and actual contact, and in the mean time exists in some Intermediate Body; or whether there exists in reality nothing but the Bodies, the Power, and the Space? In the case of the *Rays* of Light, Sounds, and Heat, and some other objects which operate at a Distance, it is indeed probable that the Intermediate Bodies are prepared and altered, the more so because a qualified Medium is required for their operation. But the Magnetic or Attractive Power admits of an indifferent Medium, and it is not impeded in any. But if that Power or Action is independent of the Intermediate Body, it follows that it is a natural Power or Action existing in a certain Time and Space without any Body, since it exists neither in the Extreme nor in the Intermediate Bodies. Hence the Magnetic Action may be taken as an *Instance of Divorce* of Corporeal Nature and Natural Action; to which we may add as a Corollary and an Advantage not to be neglected, that it may be taken as a proof of Essence and Substance being Separate and Incorporeal, even by those who philosophise according to the Senses. For if Natural Power and Action emanating from a Body can exist at any Time and Place entirely without any Body, it is nearly a proof that it can also emanate originally from an Incorporeal Substance. For a Corporeal Nature appears to be no less necessary for supporting and conveying than for exciting or generating Natural Action.

xxxviii. Next follow Five Classes of *Instances* which we are wont to call by the general term of *Instances of the Lamp*, or of *Immediate Information*. They are such as assist the Senses. For since every *Interpretation of Nature* sets out from the Senses, and leads, by a regular fixed and well established road, from the perceptions of the Senses to those of the Understanding (which are true Notions and Axioms), it necessarily follows, that in proportion as the representatives or ministerings of the Senses are more abundant and accurate, every thing else must be more easy and successful.

The first of these Five sets of *Instances of the Lamp*, strengthen, enlarge, and correct the immediate operations of the Senses. The second reduce to the sphere of the

Senses such Matters as are beyond it. The third indicate the continued Process or Series of such things and motions, as for the most part, are only observed in their termination, or in periods. The fourth supply the absolute wants of the Senses. The fifth excite their attention and observation, and at the same time limit the subtilty of things. We will now proceed to speak of them singly.

xxxix. In the Sixteenth rank then of *Prerogative Instances*, we will place the *Instances of the Door* or *Gate*, by which name we designate such as assist the immediate action of the Senses. It is obvious, that Sight holds the first rank among the Senses, with regard to information, for which reason we must seek principally helps for that Sense. These helps appear to be threefold; either to enable it to perceive objects not naturally seen, or to see them from a greater distance, or to see them more accurately and distinctly.

We have an example of the first (not to speak of Spectacles and the like, which only correct and remove the infirmity of a deficient Sight, and therefore give no further information) in the lately invented Microscopes, which exhibit the latent and invisible minutiæ of Substances, and their hidden formation and motion, by wonderfully increasing their apparent magnitude. By their assistance we behold with astonishment the accurate form and outline of a Flea, Moss, and Animalculæ, as well as their previously invisible colour and motion. It is said also that an apparently straight line, drawn with a pen or pencil, is discovered by such a Microscope to be very uneven and curved, because neither the motion of the hand, when assisted by a ruler, nor the impression of ink or colour are really regular, although the irregularities are so minute as not to be perceptible without the assistance of the Microscope. Men have (as is usual in new and wonderful discoveries) added a superstitious remark, that the Microscope sheds *a lustre* on the works of Nature, and dishonour on those of Art; which only means that the tissue of nature is much more delicate than that of art. For the Microscope is only of use for minute objects, and *Democritus* perhaps, if he had seen it, would have exulted in the thought of a means being discovered for seeing his Atom, which he affirmed to be entirely invisible. But the inadequacy of these Microscopes, for the observation of any but the most minute bodies, and even of those if parts of a larger body, destroys their utility. For if the Invention could be extended to greater bodies, or the minute parts of greater bodies, so that a piece of cloth would appear like a net, and the latent minutiæ and irregularities of Gems, Liquids, Urine, Blood, Wounds, and many other things could be rendered visible, the greatest advantage would without doubt be derived.

We have an instance of the second kind in the Telescope, discovered by the wonderful exertions of *Galileo;* by the assistance of which a nearer intercourse may be opened (as by boats or vessels) between ourselves and the Heavenly Objects. For by its aid we are assured that the Milky Way is but a knot or constellation of small stars, clearly defined and separate, which the Ancients only conjectured to be the case: whence it appears to be capable of demonstration, that the spaces of the Planetary Orbits (as they are termed) are not quite destitute of other stars, but that the Heaven begins to glitter with stars before we arrive at the starry sphere; although they may be too small to be visible without the Telescope. By the Telescope, also, we can behold the revolutions of smaller stars round Jupiter, whence it may be conjectured that there are several centres of motion among the stars. By its assistance, also, the irregularity of light and shade on the Moon's surface is more clearly observed and determined, so as to allow of a sort of Selenography. By the Telescope we see the spots in the *Sun*, and other similar phenomena; all of which are most noble Discoveries, as far as credit can be safely given to demonstrations of this nature, which are on this account very suspicious, namely, that Experiment stops at these few, and nothing further has yet been discovered by the same method, among objects equally worthy of consideration.

We have instances of the third kind in measuring Rods, Astrolabes, and the like, which do not enlarge, but correct and guide the Sight. If there be other Instances which assist the other Senses in their immediate and individual action, yet if they add nothing further to their information they are not apposite to our present purpose, and we have therefore said nothing of them.

xl. In the Seventeenth rank of *Prerogative Instances* we will place *Citing Instances* (to borrow a term from the Tribunals), because they cite those things to appear, which have not yet appeared. We are wont also to call them *Invoking Instances*, and their property is that of reducing to the sphere of the Senses objects which do not immediately fall within it.

Objects escape the Senses either from their distance, or the intervention of other bodies; or because they are not calculated to make an Impression upon the Senses; or because they are not in sufficient Quantity to strike the Senses; or because there is not sufficient time for their acting upon the Senses; or because the Impression is too violent; or because the Senses are previously filled and possessed by the object, so as to leave no room for any new motion. These remarks apply principally to Sight and next to Touch: which two Senses act extensively in giving information, and that too upon General Objects, whilst the remaining three inform us only, as it were, by their immediate action, and as to Specific Objects.

There can be no Reduction to the sphere of the Senses in the First case, unless in the place of the object, which cannot be perceived on account of the distance, there be added or substituted some other object, which can excite and strike the Sense from a greater distance, as in the communication of intelligence by Fires, Bells, and the like.

In the Second case we effect this Reduction by rendering those things which are concealed by the interposition of other bodies, and which cannot easily be laid open, evident to the Senses by means of that which lies at the surface, or proceeds from the interior; thus the state of the body is judged of by the Pulse, Urine, &c.

The Third and Fourth cases apply to many subjects, and the reduction to the sphere of the Senses must be obtained from every quarter in the Investigation of things. There are many Examples. It is obvious that Air, and Spirit, and the like, whose whole substance is extremely rare and delicate, can neither be seen nor touched; a Reduction therefore to the Senses becomes necessary in every Investigation relating to such bodies.

Let the Required Nature, therefore, be the Action and Motion of the Spirit enclosed in Tangible bodies. For every Tangible body, with which we are acquainted, contains an invisible and intangible Spirit, over which it is drawn, and which it seems to clothe. This spirit being Emitted from a Tangible substance, leaves the body contracted and dry; when Retained, it softens and melts it; when neither wholly Emitted nor Retained, it models it, endows it with limbs, assimilates, manifests, organizes it, and the like. All these points are reduced to the sphere of the Senses by manifest effects.

For in every Tangible and Inanimate Body the enclosed Spirit at first increases, and as it were feeds on the Tangible parts which are most open and prepared for it; and when it has digested and modified them, and turned them into spirit, it escapes with them. This formation and Increase of Spirit is rendered Sensible by the diminution of Weight: for in every Desiccation something is lost in Quantity, not only of the Spirit previously existing in the body, but of the body itself, which was previously Tangible, and has been recently changed, for the Spirit itself has no weight. The Departure or Emission of Spirit is rendered Sensible in the Rust of Metals, and other Putrefactions of a like nature, which stop before they arrive at the rudiments of life, which belong to the Third species of *Process*.[1] In compact bodies the Spirit does not find pores and passages for its escape, and is therefore obliged to force out, and drive before it, the Tangible parts also, which consequently protrude; whence arises Rust, and the like. The Contraction of the Tangible parts, occasioned by the emission of part of the Spirit (whence arises Desiccation), is rendered Sensible by the increased hardness of the substance, and still more by the fissures, contractions, shrivelling, and folds of the bodies thus produced. For the parts of Wood split and contract, Skins become shrivelled, and not only that, but, if the Spirit be emitted suddenly by the heat of the fire, become so hastily Contracted as to twist and roll themselves up.

On the contrary, when the Spirit is retained, and yet expanded and excited by heat, or the like (which happens in solid and tenacious bodies), then the Bodies are softened, as in hot Iron; or flow, as in Metals; or melt, as in Gums, Wax, and the like. The contrary effects of Heat, therefore (hardening some substances and melting others), are easily reconciled,[2] because the Spirit is emitted in the former and agitated and retained in the latter; the latter action is that of Heat and the Spirit, the former that of the Tangible Parts themselves after the Spirit's emission.

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[1] Rust is now well known to be a Chymical Combination of Oxygen with the Metal, and the Metal when rusty acquires additional Weight. The Theory of Spirits to which *Bacon* frequently recurs is very obscure, especially as applied to inanimate Objects. His Theory as to the Generation of Animals is deduced from the erroneous Notion of the possibility of spontaneous Generation (as it was termed). See the next paragraph but one.

[2] *Limus ut hic durescit,* et hæc ut Cera liquescit
Uno eodemque Igni.—*Virg. Ecl.* viii.

But when the Spirit is neither entirely retained nor emitted, but only strives and exercises itself, within its limits, and meets with Tangible Parts, which obey and readily follow it wherever it leads them; then follows the formation of an Organic Body, and of limbs, and the other vital actions of Vegetables and Animals. These are rendered Sensible, chiefly by diligent observation of the first beginnings, and rudiments or effects of life in Animalculæ sprung from Putrefaction, as in the eggs of Ants, Worms, Mosses, Frogs after rain, &c. Both a mild Heat and a pliant substance, however, are necessary for the Production of Life, in order that the Spirit may neither hastily escape, nor be restrained by the obstinacy of the parts, so as not to be able to bend and model them like wax.

Again, the Difference of Spirit which is important and of effect in many points (as unconnected Spirit, Branching Spirit, Branching and Cellular Spirit, the First of which is that of all inanimate Substances, the second of Vegetables, and the third of Animals), is placed, as it were, before the eyes by many Reducing Instances.

Again, it is clear that the more refined tissue and Conformation of things (though forming the whole body of visible or tangible objects) are neither visible nor tangible. Our Information, therefore, must here also be derived from Reduction to the sphere of the Senses. But the most radical and primary difference of Formation depends on the abundance or scarcity of Matter within the same space or dimensions. For the other Formations which regard the dissimilarity of the parts contained in the same body, and their collocation and position, are secondary in comparison with the former.

Let the Required Nature then be the Expansion or Coherence of matter in different bodies, or the quantity of

Matter relative to the Dimensions of each. For there is nothing in Nature more true than the twofold proposition, *That nothing proceeds from nothing*, and *that nothing is reduced to nothing*, but that the Quantum, or Sum total of matter, is constant, and is neither increased nor diminished. Nor is it less true, *that out of this given Quantity of Matter, there is a greater or less quantity, contained within the same space or dimensions according to the difference of bodies;* as, for instance, Water contains more than Air. So that if any one were to assert, that a given content of Water can be changed into an equal content of Air, it is the same as if he were to assert that Something can be reduced into Nothing. On the contrary, if any one were to assert, that a given content of Air can be changed into an equal content of Water, it is the same as if he were to assert that Something can proceed from Nothing. From this abundance or Scarcity of Matter are properly derived the Notions of *Density* and *Rarity*, which are taken in various and promiscuous senses.

This third Assertion may be considered as being also sufficiently certain; namely, that the Greater or Less quantity of Matter in this or that body, may, by Comparison, be reduced to Calculation, and exact or nearly exact Proportion. Thus, if one should say that there is such an accumulation of Matter in a given quantity of Gold, that it would require twenty-one times the quantity in dimension of Spirits of Wine, to make up the same quantity of Matter, it would not be far from the truth.

The Accumulation of Matter, however, and its relative quantity are rendered Sensible by Weight. For Weight is proportionate to the Quantity of Matter, as regards the parts of a Tangible substance, but Spirit and its Quantity of Matter are not to be computed by Weight, which Spirit rather diminishes than augments.

We have made a tolerably accurate Table of Weight, in *in which we have* selected the Weights and Size of all

Metals, the principal Minerals, Stones, Liquids, Oils, and many other Natural and Artificial bodies: a very useful proceeding both as regards Theory and Practice, and which is capable of revealing many unexpected results. Nor is this of little consequence, that it serves to demonstrate that the whole range of the variety of Tangible Bodies, with which we are acquainted (we mean tolerably close, and not spongy hollow Bodies which are for a considerable part filled with Air), does not exceed the ratio of one to twenty-one. So limited is Nature, or at least that part of it to which we are most habituated.

We have also thought it deserving our industry, to try if we could arrive at the ratio of Intangible or Pneumatic Bodies to Tangible Bodies; which we attempted by the following contrivance. We took a Vial capable of containing about an ounce, using a small Vessel in order to effect the subsequent Evaporation with less heat. We filled this Vial, almost to the neck, with Spirits of wine, selecting it as the Tangible Body which, by our Table, was the rarest, and contained a less quantity of Matter in a given Space than all other Tangible Bodies which are compact and not hollow. Then we noted exactly the weight of the Liquid and vial. We next took a Bladder, containing about two pints, and squeezed all the air out of it, as completely as possible, and until the sides of the bladder met. We first, however, rubbed the Bladder gently with oil, so as to make it air tight, by closing its pores with the oil. We tied the Bladder tightly round the mouth of the Vial, which we had inserted in it, and with a piece of waxed thread to make it fit better and more tightly, and then placed the Vial on some hot coals in a brazier. The Vapour or Steam of the Spirit, dilated and become Aeriform by the heat, gradually swelled out the Bladder, and stretched it in every direction like a sail. As soon as that was accomplished, we removed the Vial from the fire and placed it on a carpet, that it might not be cracked by the cold: we also pricked the Bladder immediately, that the steam might not return to a liquid state by the cessation of heat, and confound the proportions. We then removed the Bladder, and again took the weight of the Spirit which remained; and so calculated the quantity which had been converted into vapour, or an Aeriform shape, and then examined how much space had been occupied by the Body in its form of Spirits of wine in the Vial, and how much on the other hand had been occupied by it in its Aeriform shape in the Bladder, and subtracted the results; from which it was clear, that the Body, thus converted and changed, acquired an expansion of one hundred times beyond its former bulk.

Again, let the Required Nature be Heat or Cold, of such a degree as not to be sensible from its weakness. They are rendered Sensible by the Thermometer as we described it above;[1] for the Cold and Heat are not actually perceived by the touch, but Heat expands and Cold contracts the Air. Nor, again, is that Expansion or Contraction of the Air in itself Visible, but the Air when Expanded depresses the Water, and when Contracted raises it, which is the first reduction to Sight.

Again, let the Required Nature be the Mixture of Bodies; namely, how much Aqueous, Oleaginous, or Spirituous, Ashy or Salt parts they contain; or, as a particular example, how much Butter, Cheese, and Whey there is in Milk, and the like? These things are rendered Sensible by artificial and skilful Separations in Tangible substances, and the nature of the Spirit in them, though not immediately perceptible, is nevertheless discovered by the various motions and efforts of Bodies. And, indeed, in this branch men have laboured hard in Distillations and artificial Separations, but with little more success than in their other Experiments now in use; their methods being mere guesses and blind attempts, and more industrious than intelligent; and what is worst of all, without any imitation or rivalry of Nature, but rather by violent Heats and too energetic agents, to the destruction of any delicate Conformation, in which principally consist the hidden Virtues and sympathies. Nor do men in these Separations ever attend to or observe what we have before pointed out; namely, that in attacking Bodies by fire, or other methods, many qualities are superinduced by the Fire itself, and the other bodies used to effect the Separation, which were not originally in the Compound. Hence arise most extraordinary fallacies. For the mass of Vapour, which is emitted from Water by Fire for instance, did not exist as Vapour or Air in the Water, but is chiefly created by the expansion of the Water by the heat of the Fire.

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[1] See Table of Degrees, No. 38.

So in general all delicate Experiments on Natural or Artificial Bodies, by which the Genuine are distinguished from the Adulterated, and the Better from the more Common, should be referred to this division; for they bring that which is not the Object of the Senses within their sphere. They are therefore to be everywhere diligently sought after.

With regard to the fifth cause of Objects escaping our Senses, it is clear that the Action of the Sense takes place by Motion, and this Motion is Time. If, therefore, the Motion of any body be either so slow, or so swift, as not to be proportioned to the necessary Momentum which operates on the Senses, the Object is not perceived at all; as in the Motion of the Hour Hand, and that again of a Musket Ball. The Motion which is imperceptible by the Senses from its slowness, is readily and usually rendered sensible by the Accumulation of Motion; that which is imperceptible from its velocity, has not as yet been well measured; it is necessary, however, that this should be done in some cases, with a view to a proper Investigation of Nature.

The sixth case, where the Sense is impeded by the power of the Object, admits of a Reduction to the sensible sphere, either by Removing the Object to a greater distance, or by Deadening its effects by the Interposition of a Medium, which may weaken and not destroy the Object; or by the Admission of its Reflection where the Direct Impression is too strong, as that of the Sun in a basin of water.

The seventh case, where the Senses are so overcharged with the Object as to leave no further room, scarcely occurs except in the Smell or Taste, and is not of much consequence as regards our present subject. Let what we have said therefore suffice with regard to the Reduction to the Sensible sphere of objects not naturally within its compass.

Sometimes, however, this Reduction is not extended to the Senses of man, but to those of some other Animal, whose Senses, in some points, exceed those of man: as (with regard to some Scents) to that of the Dog, and with regard to Light existing imperceptibly in the air, when not illuminated from any extraneous source, to the sense of the Cat, the Owl, and other Animals which see by night. For *Telesius* has well observed that there appears to be an original portion of Light even in the Air itself, although but slight and meagre, and of no use for the most part to the eyes of men, and those of the generality of animals; because those Animals to whose Senses this light is proportioned can see by night, which does not, in all probability, proceed from their seeing either without light, or by any internal light.

Here too we would observe, that we at present discuss only the Wants of the Senses, and their remedies; for their Deceptions must be referred to the Inquiries appropriated to the Senses, and Sensible Objects; except that important Deception, which makes them define objects in their relation to Man, and not in their relation to the Universe, and which is only corrected by universal Reasoning and *Philosophy*.

xli. In the Eighteenth rank of *Prerogative Instances* we will class the *Instances of the Road*, which we are also wont to call *Itinerant* and *Jointed Instances*. They are such as indicate the gradually continued Motions of Nature. This species of Instances escapes rather our Observation, than our Senses; for men are wonderfully indolent upon this subject, consulting Nature in a desultory manner, and at periodic intervals, when bodies have been regularly finished and completed, and not during her work. But if any one were desirous of examining and contemplating the Talents and industry of an Artificer, he would not merely wish to see the rude materials of his Art, and then his work when finished, but rather to be present whilst he is at labour, and proceeding with his work. Something of the same kind should be done with regard to Nature. For instance, if any one investigate the vegetation of Plants, he should observe from the first sowing of any seed (which can easily be done by pulling up every day seeds which have been two, three, or four days in the ground, and examining them diligently), how and when the seed begins to swell and break, and be filled as it were with spirit; then how it begins to burst the bark and push out fibres, raising itself a little at the same time, unless the ground be very stiff; then how it pushes out these fibres, some downwards for roots, others upwards for the stem, sometimes also creeping laterally, if it find the earth open and more yielding on one side, and the like. The same should be done in observing the hatching of Eggs, where we may easily see the Process of animation and organisation, and what parts are formed of the yolk, and what of the white of the Egg, and the like. The same may be said of the inquiry into the formation of Animals from putrefaction; for it would not be so humane to inquire into perfect and terrestrial Animals, by cutting the fœtus from the womb; but opportunities may perhaps be offered of abortions, animals killed in hunting and the like. Nature, therefore, must, as it were, be watched, as being more easily observed by night than by day: for Contemplations of this kind may be considered as carried on by Night, from the minuteness and perpetual burning of our watch-light.

The same must be attempted with Inanimate Objects, which we have ourselves done by Inquiring into the Opening of Liquids by fire. For the mode in which water expands is different from that observed in Wine, Vinegar, or Verjuice, and very different again from that observed in Milk and Oil, and the like; and this was easily seen, by boiling them with slow heat in a glass vessel, through which the whole may be clearly perceived. But we merely mention this, intending to treat of it more at large and more closely when we come to the discovery of the *Latent Process;* for it should always be remembered that we do not here treat of Things themselves, but merely propose Examples.

xlii. In the Nineteenth rank of *Prerogative Instances* we will class *Supplementary* or *Substitutive Instances*, which we are also wont to call *Instances of Refuge.* They are such as supply Information, where the Senses are entirely deficient, and we, therefore, have recourse to them when appropriate Instances cannot be obtained. This Substitution is twofold, either by Approximation or by Analogy. For instance; there is no known Medium, which entirely prevents the effect of the Magnet in attracting iron, neither Gold, nor Silver, nor Stone, nor Glass, Wood, Water, Oil, Cloth, or fibrous Bodies, Air, Flame, or the like. Yet by accurate experiment, a Medium may perhaps be found which would deaden its effect, more than another comparatively and in degree; as for instance, the Magnet would not perhaps attract iron through the same thickness of Gold as of Air, or the same quantity of ignited as of cold Silver, and so on: for we have not ourselves made the Experiment but it will suffice as an Example. Again, there is no known Body *which is not* susceptible of Heat, when brought near the fire. Yet Air becomes warm much sooner than Stone. These are examples of Substitution by Approximation.

Substitution by Analogy is useful, but less sure, and therefore to be adopted with some judgment. It serves to reduce that which is not the Object of the Senses to their sphere, not by the Perceptible operations of the Imperceptible body, but by the consideration of some similar Perceptible Body. For instance, let the subject for inquiry be the Mixture of Spirits, which are invisible Bodies. There appears to be some relation between bodies and their Sources or Support. Now, the source of Flame seems to be Oil and Fat; that of Air, Water, and Watery Substances; for Flame increases over the exhalation of Oil, and Air over that of Water. One must therefore consider the Mixture of Oil and Water, which is manifest to the Senses, since that of Air and Flame in general escapes the Senses. But Oil and Water mix very imperfectly by composition, or stirring, whilst they are exactly and nicely mixed in Herbs, Blood, and the Parts of Animals. Something similar therefore may take place in the Mixture of Flame and Air in Spirituous Substances, not bearing Mixture very well by simple Collision, whilst they appear, however, to be well mixed in the Spirits of Plants and Animals.

Again, if the inquiry do not relate to Perfect Mixtures of Spirits, but merely to their Composition, as whether they easily incorporate with each other, or there be rather (as an example) certain Winds and Exhalations, or other Spiritual Bodies, which do not mix with common Air, but only adhere to and float in it in globules and drops, and are rather broken and pounded by the Air, than received into, and incorporated with it; this cannot be perceived in Common Air, and other Æriform Substances, on account of the rarity of the bodies, but an image, as it were, of this process, may be conceived in such Liquids as Quicksilver, Oil, Water, and even Air, when broken and dissipated it ascends in small portions through Water, and also in the thicker kinds of Smoke; lastly in Dust, raised and remaining in the Air, in all of which there is no Incorporation: and the above Representation in this Respect is not a bad one, if it be first diligently investigated, whether there can be such a difference of nature between Spirituous Substances, as between Liquids, for then these Images might conveniently be substituted by Analogy.

And although we have observed of these *Supplementary Instances*, that Information is to be derived from them, when appropriate Instances are wanting, by way of *Refuge*, yet we would have it understood, that they are also of great use, when the Appropriate Instances are at hand, in order to confirm the Information afforded by them; of which we will speak more at length, when our subject leads us, in due course, to the *Support of Induction*.

xliii. In the Twentieth rank of *Prerogative Instances* we will place *Lancing Instances*, which we are also wont (but for a different reason) to call *Twitching Instances*. We adopt the latter name, because they twitch the Understanding, and the former because they pierce Nature, whence we style them occasionally the *Instances of Democritus*.[1] They are such as warn the Understanding of the admirable and exquisite Subtilty of Nature, so that it becomes roused and awakened to attention, observation, and proper inquiry: as, for instance, that a little drop of Ink should be drawn out into so many letters; that Silver merely gilt on its surface should be stretched to such a length of gilt wire; that a little Worm, such as you may find on the skin, should possess both a spirit and a varied conformation of its parts; that a little Saffron should imbue a whole tub of Water with its colour; that a little Musk or Aroma should imbue a much greater extent of Air with its perfume; that a cloud of smoke should be raised by a little incense; that such accurate differences of Sounds as articulate words should be conveyed in all directions through the Air, and even penetrate the pores of Wood and Water (though they become much weakened), that they should be moreover reflected, and that with such distinctness and velocity; that Light and Colour should for such an extent, and so rapidly pass through solid bodies, such as Glass and Water, with so great and so exquisite a variety of images, and should be refracted and reflected; that the Magnet should attract through every description of body even the most compact; but (what is still more wonderful) that in all these cases the action of one should not impede that of another in a common Medium, such as Air; and that there should be borne through the air, at the same time, so many images of Visible objects, so many impulses of Articulation, so many different perfumes, as of the Violet, Rose, &c. besides Cold and Heat, and Magnetic Attractions; all of them, I say, at once, without any impediment from each other, as if each had its paths and peculiar passage set apart for it, without infringing against or meeting each other.

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[1] Alluding to his theory of Atoms.

To these *Lancing Instances*, however, we are wont, not without some advantage, to add those which we call the *Limits* of such Instances. Thus, in the cases we have pointed out, one action does not disturb or impede another of a different nature, yet those of a similar nature subdue and extinguish each other; as the light of the Sun does that of the Candle, the sound of a Cannon that of the voice, a strong Perfume a more delicate one, a powerful Heat a more gentle one, a Plate of Iron between the Magnet and other Iron the effect of the Magnet. But the proper place for mentioning these will be also amongst the *Supports of Induction*.

xliv. We have now spoken of the Instances which assist the Senses, and which are principally of service as regards

Information; for Information begins from the Senses. But our whole labour terminates in Practice, and as the former is the beginning, so is the latter the end of our subject. The following Instances, therefore, will be those which are chiefly useful in *Practice*. They are comprehended in two classes, and are seven in number. We call them all by the general name of *Practical Instances*. Now there are two Defects in *Practice*, and as many divisions of Important Instances. Practice is either deceptive or too laborious. It is generally Deceptive (especially after a diligent Examination of Natures), on account of the power and actions of Bodies being ill defined and determined. Now the powers and Actions of bodies are defined and determined either by Space or by Time, or by the Quantity at a given period, or by the predominance of Energy; and if these four circumstances be not well and diligently considered, the Sciences may indeed be beautiful in theory, but are of no effect in practice. We call the four Instances referred to this class *Mathematical Instances* and *Instances of Measure*.

Practice is laborious either from the Multitude of Instruments, or the Bulk of matter and Substances requisite for any given work. Those instances, therefore, are valuable, which either direct Practice to that which is of most consequence to mankind, or lessen the number of Instruments, or of Matter to be Worked upon. We assign to the three Instances relating to this class the common name of *Propitious* or *Benevolent Instances*. We will now separately discuss these seven Instances, and conclude with them that part of our work which relates to the Prerogative or Illustrious Instances.

xlv. In the twenty-first rank of Prerogative Instances we will place the *Instances of the Rod or Rule*, which we are also wont to call the *Instances of Completion*, or *Non ultrà*. For the Powers and Motions of bodies do not act and take effect through *indefinite* and accidental, but through limited and certain spaces; and it is of great importance to Practice that these should be understood and noted in every Nature which is investigated; not only to prevent deception, but to render practice more extensive and efficient. For it is sometimes possible to extend these Powers, and bring the Distance, as it were, nearer, as in the example of Telescopes.

Many Powers act and take effect only by actual Touch, as in the percussion of Bodies; where the one does not remove the other, unless the impelling touch the impelled body. External applications in Medicine, as Ointment, and Plasters, do not exercise their efficacy, except when in Contact with the Body. Lastly, the Objects of Touch and Taste only strike those Senses when in contact with their Organs.

Other Powers act at a Distance, though it be very small, of which but few have as yet been noted, although there be more than men suspect; this happens (to take Every Day instances) when Amber or Jet attracts straws, Bubbles dissolve bubbles, some purgative Medicines draw humours from above, and the like. The Magnetic Power by which Iron and the Magnet, or two Magnets, are attracted together, acts within a definite and narrow sphere, but if there be any Magnetic Power emanating from the Earth, a little below its surface, and affecting the Needle in its polarity, it must act at a great Distance.

Again, if there be any Magnetic Force, which acts by Sympathy between the globe of the Earth and Heavy Bodies, or between that of the Moon and the Waters of the Sea (as seems most probable from the particular Floods and Ebbs which occur Twice in the Month), or between the Starry Sphere and the Planets, by which they are summoned and raised to their Apogees; these must all operate at very great distances.[1] Again, some Conflagrations and the Kindling of Flames take place at very considerable

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[1] Observe the Approximation to *Newton's* Theory.

Distances, with particular Substances, as they report of the Naphtha of Babylon. Heat too insinuates itself at wide Distances, as does also Cold, so that the Masses of ice which are broken off and float upon the *Northern Ocean*, and are borne through the Atlantic to the coast of *Canada*, become perceptible by the Inhabitants, and strike them with cold from a distance. Perfumes also (though here there appears to be always some corporeal Emission) act at remarkable Distances; as is experienced by persons sailing by the coast of *Florida*, or parts of *Spain*, where there are whole woods of Lemons, Oranges, and other odoriferous Plants, or Rosemary and Marjoram bushes, and the like. Lastly, the Rays of Light, and the Impressions of Sound act at extensive Distances.

Yet all these powers, whether acting at a small or great Distance, certainly act within definite distances, which are well ascertained by Nature; so that there is a *Limit* depending either on the Mass or Quantity of the Bodies, the Vigour or Faintness of the Powers, or the Favourable or Impeding Nature of the Medium, all of which should be taken into account and observed. We must also note the Boundaries of Violent Motions, such as Missiles, Projectiles, Wheels, and the like, since they are also manifestly confined to certain limits.

Some Motions and Virtues are to be found of a directly contrary nature to these, which act in Contact but not at a Distance; namely, such as operate at a Distance, and not in Contact, and again act with less force at a less Distance, and the reverse. Sight, for instance, is not easily effective in Contact, but requires a Medium and Distance; although I remember having heard from a person deserving of credit, that in being cured of a Cataract (which was done by putting a small silver Needle within the first coat of the eye to remove the thin pellicle of the Cataract, and force it into *a corner of the* eye), he had distinctly seen the ne moving across the pupil. Still, though this may be true, it is clear that large bodies cannot be seen well or distinctly, unless at the vertex of a Cone, where the rays from the Object meet at some Distance from the eye. In Old persons the Eye sees better if the Object be moved a little farther and not nearer. Again, it is certain, that in Projectiles the impact is not so violent at too short a Distance as a little afterwards.[1] Such are the observations to be made on the Measure of Motions as regards distance.

There is another Measure of Motion in Space which must not be passed over, not relating to Progressive but Spherical Motion; that is, the Expansion of Bodies into a Greater, or their Contraction into a lesser Sphere. For in our Measure of this motion we must inquire, what degree of Compression or Extension Bodies easily and readily admit of, according to their Nature, and at what Point they begin to resist it, so as, at last, to bear it *No further;* as when an inflated Bladder is compressed, it allows a certain Compression of the Air, but if this be increased, the Air does not suffer it, and the Bladder is burst.

We have proved this by a more delicate Experiment. We took a Metal Bell, of a light and thin sort such as is used for Salt-cellars, and immerged it in a basin of Water, so as to carry the air contained in its Interior down with it to the bottom of the basin. We had first, however, placed a Small Globe at the bottom of the basin, over which we placed the Bell. The result was, that if the Globe were small, compared with the Interior of the bell, the Air would contract itself, and be compressed without being forced out, but if it were too large for the Air readily to yield to it, the latter became impatient of the Pressure, raised the Bell partly up, and ascended in bubbles.

To prove also the Extension (as well as the Com- hich Air admits of, we adopted the following method. We took a glass Egg, with a small hole at one end; we drew out the Air by violent suction at this hole, and then closed the hole with the finger, immersed the Egg in Water, and then removed the finger. The Air being constrained by the effort made in Suction, and dilated beyond its Natural State, and therefore striving to recover and contract itself (so that if the Egg had not been immersed in Water it would have drawn in the Air with a hissing Sound), now drew in a sufficient quantity of Water to allow the Air to recover its former dimensions.[1]

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[1] Query.

It is well ascertained that rare Bodies (such as Air) admit of considerable Contraction, as has been before observed; but tangible Bodies (such as Water) admit of it much less readily, and to a less extent. We investigated the latter point by the following Experiment.

We had a leaden Globe made, capable of containing about two pints, wine measure, and of tolerable thickness, so as to support considerable pressure. We poured Water into it through an aperture, which we afterwards closed with melted lead, as soon as the Globe was filled with Water, so that the Whole became perfectly solid. We next flattened the two opposite sides with a heavy Hammer, which necessarily caused the Water to occupy a less space, since the Sphere is the Solid of greatest Content; and when Hammering failed from the resistance of the Water, we made use of a Mill or Press, till at last the Water, refusing to submit to a greater Pressure, exuded like a fine Dew through the solid lead. We then computed the extent to which the original space had been reduced, and concluded that Water admitted such a degree of Compression when constrained by great violence.

The more Solid, Dry, or Compact Bodies, such as

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[1] This passage shows that the Pressure of the External Atmosphere, which forces the Water into the Egg, was not in *Bacon's* time understood.

Stones, Wood, and Metals, admit of much less and indeed scarcely any perceptible Compression, or Expansion, but escape by Breaking, Slipping Forward, or other Efforts; as appears in Bending Wood, or Steel for Watchsprings, in Projectiles Hammering, and many other Motions, all of which, together with their Degrees, are to be observed and examined in the Investigation of Nature, either to a Certainty, or by Estimation, or Comparison, as Opportunity permits.

xlvi. In the twenty-second rank of *Prerogative Instances* we will place the *Instances of the Course*, which we are also wont to call *Water Instances;* borrowing our expression from the Water Hour-glasses, employed by the Ancients instead of those with Sand. They are such as measure Nature by the Moments of Time, as the last *Instances* do by the Degrees of Space. For all Motion or Natural Action takes place in Time, more or less rapidly, but still in determined Moments well ascertained by Nature. Even those Actions which appear to take effect suddenly, and in the Twinkling of an eye (as we express it), are found to admit of Greater or Less Rapidity.

In the first place, then, we see that the Return of the Heavenly Bodies to the same place takes place in regular Times, as does the Flood and Ebb of the Sea. The descent of Heavy Bodies towards the Earth, and the ascent of Light Bodies towards the Heavenly Sphere, take place in definite Times, according to the nature of the Body, and of the Medium through which it moves. The Sailing of Ships, the Motions of Animals, the Transmission of Projectiles, all take place in Times, the Sums of which can be computed. With regard to Heat, we see that Boys in winter bathe their hands in the flame without being burnt; and Conjurers, by quick and regular movements, overturn vessels filled with Wine or Water, and replace them without spilling the liquid, with several similar instances. The

Compression, Expansion, and Eruption of several Bodies, take place more or less rapidly, according to the Nature of the Body, and its Motion, but still in definite Moments.

In the explosion of several Cannon at once (which are sometimes heard at the Distance of thirty miles), the Sound of those nearest to the spot is heard before that of the most distant. Even in Sight (whose Action is most rapid), it is clear that a definite Time is necessary for its exertion, which is proved by certain objects being invisible from the velocity of their Motion, such as a Musket Ball. For the Flight of the Ball is too swift to allow an impression of its Figure to be conveyed to the Sight.

This last instance, and others of a like nature, have sometimes excited in us a most marvellous doubt, no less than whether the Image of the Sky and Stars is perceived as at the actual Moment of its existence, or rather a little after, and whether there is not (with regard to the Visible Appearance of the Heavenly Bodies) a true and apparent Time, as well as a true and apparent Place, which is observed by Astronomers in Parallaxes.[1] It appeared so incredible to us, that the Images or Radiations of Heavenly Bodies could suddenly be conveyed through such immense spaces to the Sight, and it seemed that they ought rather to be transmitted in a definite time. That Doubt, however (as far as regards any great difference between the True and Apparent Time), was subsequently completely set at rest, when we considered the infinite Loss and diminution of Size as regards the Real and Apparent Magnitude of a Star, occasioned by its Distance, and at the same time observed at how great a Distance (at least sixty miles) Bodies which are merely White can be suddenly seen by us. For there is no doubt, that the Light of the Heavenly Bodies not only far surpasses the vivid appearance of White, but even the

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[1] This is a singular Approximation to *Rœmer's* Discovery of Time being required for the Propagation of Light.

Light of any Flame (with which we are acquainted) in the vigour of its radiation. The immense Velocity of the Bodies themselves which is perceived in their Diurnal Motion, and has so astonished thinking men, that they have been more ready to believe in the Motion of the Earth, renders the Motion of Radiation from them (marvellous as it is in its rapidity) more worthy of belief. That which has weighed most with us, however, is, that if there were any considerable interval of Time between the Reality and the Appearance, the images would often be interrupted and confused by clouds formed in the mean time, and similar disturbances of the medium. Let this suffice with regard to the Simple Measures of Time.

It is not merely the Absolute, but still more the Relative Measure of Motions and Actions which must be inquired into, for this latter is of great use and application. We perceive that the Flame of Fire-Arms is seen sooner than the Sound is heard, although the ball must have struck the Air before the Flame, which was behind it, could escape: the reason of which is, that Light moves with greater Velocity than Sound. We perceive, also, that Visible Images are received by the Sight with greater rapidity than they are dismissed, and for this reason, a Violin String touched with the finger appears double or triple, because the new Image is received before the Former One is dismissed. Hence, also, Rings when spinning appear globular, and a lighted Torch, borne rapidly along at night, appears to have a Tail. Upon the principle of the Inequality of Motion, also, *Galileo* attempted an explanation of the Flood and Ebb of the Sea, supposing the Earth to move rapidly, and the Water slowly, by which means the Water, after accumulating, would at intervals fall back, as is shown in a vessel of Water made to move rapidly. He has, however, imagined this on data which cannot be granted (namely the Earth's motion), and besides does not satisfactorily account for the Tide taking place every Six hours.

An Example of our present point (the Relative Measure of Motion), and, at the same time, of its remarkable Use of which we have spoken, is conspicuous in Mines filled with Gunpowder, where immense Weights of Earth, Buildings, and the like, are overthrown and prostrated by a small quantity of Powder; the Reason of which is decidedly this, that the Motion of the Expansion of the Gunpowder is much more rapid than that of Gravity, which would resist it, so that the former has terminated before the latter has commenced. Hence, also, in Missiles, a strong Blow will not carry them so far as a sharp and rapid one. Nor could a small portion of Animal Spirit in Animals, especially in such vast Bodies as those of the Whale and Elephant, have ever bent or directed such a mass of Body, were it not owing to the Velocity of the former, and the slowness of the latter in resisting its Motion.

In short, this point is one of the principal foundations of the Magic Experiments (of which we shall presently speak), where a small Mass of Matter overcomes and regulates a much larger, if there but be an Anticipation of Motion, by the Velocity of one before the other is prepared to act.

Finally, the point of the *First* and *Last* should be observed in all Natural Actions. Thus in an Infusion of Rhubarb the Purgative Property is first extracted, and then the Astringent; we have experienced something of the same kind in Steeping Violets in Vinegar, which first extracts the sweet and delicate odour of the Flower, and then the more earthy part, which disturbs the perfume; so that if the Violets be steeped a whole day, a much fainter Perfume is extracted than if they were steeped for a quarter of an hour only, and then taken out; and since the odoriferous Spirit in the Violet is not abundant, let other and fresh Violets be steeped in the vinegar every quarter of an hour, as many as six times, when the Infusion becomes so strengthened, that although the Violets have not altogether remained there for more than one hour and a half, there remains a most pleasing Perfume, not inferior to the Flower itself, for a whole year. It must be observed, however, that the Perfume does not acquire its full strength, till about a month after the Infusion. In the Distillation of Aromatic Plants macerated in spirits of wine, it is well known that an aqueous and useless phlegm rises first, then Water containing more of the spirit; and lastly water containing more of the Aroma; and many observations of the like kind, well worthy of notice, are to be made in Distillations. But let these suffice as Examples.

xlvii. In the Twenty-third rank of *Prerogative Instances* we will place *Instances of quantity*, which we are also wont to call the *Doses of Nature* (borrowing a word from Medicine). They are such as Measure the Powers by the *Quantity* of Bodies, and point out the effect of the *Quantity* in the *Degree of Power*. And in the first place, some Powers only subsist in the *Universal Quantity*, or such as bears a relation to the Conformation and Fabric of the Universe. Thus the Earth is fixed, its parts fall. The Waters in the Sea flow and ebb, but not in the Rivers, except by the admission of the Sea. Then, again, almost all particular Powers act according to the *Greater* or *Less* quantity of the Body. Large masses of Water are not easily rendered foul, small are. New Wine and Beer become ripe and drinkable in small skins much more readily than in large casks. If an Herb be placed in a considerable quantity of Liquid, Infusion takes place rather than Impregnation, if in *Less* the Reverse. A Bath therefore and a light Sprinkling produce different effects on the Human Body. Light Dew again never falls, but is dissipated and incorporated with the Air; thus we see that in breathing on Gems the slight quantity of moisture, like a small cloud in the air, is immediately dissolved. Again, a piece of the same Magnet does not attract so much Iron as the whole Magnet did. There are some Powers where the Smallness of the *Quantity* is of more avail; as in boring, a sharp point pierces more readily than a blunt one; the Diamond, when pointed, makes an impression on glass, and the like.

Here, too, we must not rest contented with a Vague Result, but inquire into the exact *Proportion of Quantity* requisite for a particular exertion of Power. For one would be apt to suppose that the Power bears an exact Proportion to the Quantity; that if a leaden Bullet of one ounce, for instance, would fall in a given time, one of two ounces ought to fall twice as rapidly, which is most erroneous. Nor does the same ratio prevail in every kind of Power, their difference being considerable. The Measure, therefore, must be determined by experiment and not by probability or Conjecture.

Lastly, we must in all our Investigations of Nature observe what *Quantity*, or Dose, of the Body is requisite for a given Effect, and must at the same time be Guarded against estimating it at *too Much* or *too Little.*

xlviii. In the Twenty-fourth rank of *Prerogative Instances* we will place *Wrestling Instances*, which we are also wont to call *Instances of Predominance.* They are such as point out the Predominance and Submission of Powers compared with each Other, and which of them is the more energetic and superior, or more weak and inferior. For the Motions and Effects of Bodies are compounded, decomposed, and combined, no less than the Bodies themselves. We will exhibit, therefore, the principal Kinds of Motions or Active Powers, in order that their Comparative Strength, and thence a Demonstration and Definition of the *Instances* in question, may be rendered more clear.

Let the first Motion be that of the *Resistance of Matter*, which exists in every particle, and completely prevents its Annihilation; so that no conflagration, weight, pressure, violence, or length of time, can reduce even the smallest portion of Matter to Nothing, or prevent it from being Something, and occupying some Space, and delivering itself (whatever straits it be put to), by changing its Form or Place, or, if that be impossible, remaining as it is, nor can it ever happen that it should either be Nothing or Nowhere. This Motion is designated by the Schools (which generally name and define every Thing by its Effects and Inconveniences rather than by its Inherent Cause) by the Axiom; that *Two bodies cannot exist in the same place*, or they call it a Motion *To prevent the penetration of dimensions.* It is useless to give examples of this Motion since it exists in every Body.

Let the Second Motion be that which we term the Motion of *Connexion*, by which Bodies do not allow themselves to be separated at any point from the contact of another Body, delighting, as it were, in the mutual connexion and contact. This is called by the Schools a Motion *To prevent a vacuum.* It takes place when Water is drawn up by suction or a Syringe, the Flesh by Cupping, or when the Water remains without escaping from perforated Jars, unless the mouth be opened to admit the Air, and innumerable instances of a like nature.

Let the Third be that which we term the Motion of *Liberty*; by which bodies strive to deliver themselves from any Unnatural Pressure or Tension, and to restore themselves to the Dimensions suited to their mass; and of which also there are innumerable examples. Thus we have examples of their Escaping from Pressure, in the Water in Swimming, in the Air in Flying, in the Water again in Rowing, and in the Air in the Undulation of the Winds, and in Springs of Watches. An exact instance of the Motion of compressed Air is seen in children's Popguns, which they make by scooping out Elder branches or some such matter, and forcing in a piece of some pulpy Root or the like, at each end; then they force the root or other pellet with a Ramrod to the opposite end, from which the lower Pellet is emitted and projected with a report, and that before it is touched by the other piece of Root or Pellet, or by the Ramrod. We have examples of their Escape from Tension, in the Motion of the Air that remains in glass Eggs after suction, in Strings, Leather, and Cloth, which recoil after Tension, unless it be long continued. The Schools define this by the term of Motion *from the Form of the Element;* injudiciously enough, since this Motion is tó be found not only in Air, Water, or Fire, but in every species of Solid, as Wood, Iron, Lead, Cloth, Parchment, &c. each of which has its own proper Size, and is with difficulty stretched to any other. Since, however, this Motion of Liberty is the most obvious of all, and to be seen in an infinite number of cases, it will be as well to distinguish it correctly and clearly; for some most carelessly confound this with the two others of *Resistance* and *Connexion;* namely, the Freedom from Pressure with the former, and that from Tension with the latter; as if bodies when compressed yielded or expanded to prevent a *Penetration of dimensions*, and when stretched rebounded and contracted themselves to prevent a *Vacuum*. But if the Air, when compressed, could be brought to the density of Water, or Wood to that of Stone, there would be no need of any *Penetration of dimensions*, and yet the Compression would be much greater than they actually admit of. So if Water could be expanded till it became as rare as Air, or Stone as rare as Wood, there would be no need of a *Vacuum*, and yet the Expansion would be much greater than they actually admit of. We do not, therefore, arrive at a *Penetration of dimensions* or a *Vacuum* before the extremes of Condensation and Rarefaction, whilst the Motion we speak of stops and exerts itself much within them, and is nothing more than a Desire of Bodies to preserve their specific Density (or if it be preferred, their Form), and not to desert them suddenly, but only to change by degrees, and of their own accord. It is, however, much more necessary to intimate to mankind (because many other points depend upon this), that the Violent Motion which we call *Mechanical*, and *Democritus* (who, in explaining his primary Motions, is to be ranked even below the Middling class of Philosophers) termed the Motion of a *Blow*, is nothing else than this Motion of Liberty, namely, a tendency to Relaxation from Compression. For in all simple Impulsion or Flight through the Air, the Body is not displaced or Moved in Space, until its parts are placed in an Unnatural State and compressed by the Impelling Force. When that takes place, the different parts urging the other in succession, the Whole is moved, and that with a Rotatory as well as Progressive Motion, in order that the Parts may, by this means also, set themselves at liberty, or more readily submit. Let this suffice for the Motion in question.

Let the Fourth be that which we term the Motion of *Matter*, and which is opposed to the last. For in the Motion of Liberty, Bodies abhor, reject, and avoid a New Size or Volume, or any new Expansion or Contraction (for these different Terms have the same meaning), and strive, with all their power, to rebound and resume their former Density. On the contrary, in the Motion of *Matter*, they are anxious to acquire a new Volume or Dimension, and attempt it willingly and rapidly, and occasionally by a most vigorous effort, as in the example of Gunpowder. The most powerful, or at least most frequent, though not the only Instruments of this motion, are Heat and Cold. For instance; the Air, if expanded by tension (as by suction in the glass Egg), struggles anxiously to restore itself; but if Heat be applied, it strives on the contrary to dilate itself, and longs for a larger volume, regularly passing and migrating into it, as into a new Form (as it is termed): nor after a certain degree of expansion is it anxious to return, unless it be invited to do so by the application of Cold, which is not indeed a Return, but a fresh Change. So also Water, when confined by compression, resists, and wishes to become as it was before, namely, more expanded; but if there happen an intense and continued Cold, it changes itself readily, and of its own accord, into the condensed state of Ice; and if the Cold be long continued, without any intervening warmth (as in Grottos and deep Caves) it is changed into Crystal or similar matter, and never resumes its form.

Let the Fifth be that which we term the Motion of *Continuity*. We do not understand by this simple and primary Continuity with any other body (for that is the Motion of *Connexion*), but the Continuity of a particular Body in itself. For it is most certain, that all Bodies abhor a solution of Continuity, some more and some less, but all partially. In Hard Bodies (such as Steel and Glass), the Resistance to an Interruption of Continuity is most powerfull and efficacious, whilst although in Liquids it appears to be faint and languid, yet it is not altogether null, but exists in the lowest degree, and shows itself in many Experiments, such as bubbles, the round form of Drops, the thin threads which Drip from Roofs, the cohesion of Glutinous Subtances, and the like. It is most conspicuous, however, if an Attempt be made to push this Separation to still smaller particles. Thus, in Mortars, the Pestle produces no effect after a certain degree of contusion, Water does not penetrate small fissures, and the Air itself, notwithstanding its subtilty, does not penetrate the Pores of solid Vessels at once, but only by long continued insinuation.

Let the Sixth be that which we term the Motion of *Acquisition*, or the Motion of *Need*. It is that by which Bodies placed amongst others of a Heterogeneous and, as it were, Hostile nature, if they meet with the means or *opportunity of avoiding* them, and uniting themselves with others of a more Analogous Nature, even when these latter are not closely allied to them, immediately seize and, as it were, select them, and appear to consider it as something Acquired (whence we derive the name), and to have need of these latter bodies. For instance, Gold, or any other Metal in leaf, does not like the neighbourhood of Air; if, therefore, they meet with any Tangible and Thick Substance (such as the Finger, Paper, or the like), they immediately adhere to it and are not easily torn from it. Paper, too, and Cloth, and the like, do not agree with the Air, which is inherent and mixed in their Pores. They readily, therefore, imbibe Water or other Liquids, and get rid of the Air. Sugar, or a Sponge, dipped in Water or Wine, and though part of it be out of the Water or Wine, and at some height above it, will yet gradually absorb them.

Hence an excellent Rule is derived for the Opening and Dissolution of Bodies. For (not to mention Corrosive and strong Waters which force their way), if a Body can be found which is more adapted, suited, and friendly, to a given solid, than that with which it is by some necessity united, the given solid immediately opens and dissolves itself to receive the former and excludes or removes the latter.[1] Nor is the effect or power of this Motion confined to Contact, for the Electric Energy (of which *Gilbert* and others after him have told so many fables) is only the Energy excited in a Body by gentle friction, and which does not endure the Air, but prefers some tangible substance if there be any at hand.

Let the Seventh be that which we term the Motion of *Greater Congregation*, by which Bodies are borne towards Masses of a Similar Nature, for instance, Heavy Bodies towards the Earth, Light to the Sphere of Heaven. The Schools termed this *Natural Motion*, by a superficial consideration of it, because produced by no external visible Agent, which made them consider it innate in the Substances; or, perhaps, because it does not cease, which is little to be wondered at, since Heaven and Earth are always present, whilst the causes and sources of many other Motions are sometimes absent and sometimes present. They therefore called this Perpetual and Proper, because it is never interrupted, but instantly takes place when the others are interrupted, and they called the others Adscititious. The former, however, is in reality weak and slow, since it yields, and is inferior to the others as long as they act, unless the Mass of the Body be great; and although this Motion have so filled men's minds, as almost to have obscured all others, yet they know but little about it, and commit many errors in its estimate.

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[1] This is one of the most Useful Practical Methods in Chymistry at the present day.

Let the Eighth be that which we term the Motion of *Lesser Congregation*, by which the Homogeneous Parts in any Body separate themselves from the Heterogeneous and unite together, and Whole Bodies of a similar substance coalesce and tend towards each other, and are sometimes congregrated, attracted, and meet, from some distance; thus in Milk the Cream rises after a certain time, and in Wine the Dregs and Tartar sink; which effects are not to be attributed to Gravity and Levity only, so as to account for the rising of some parts and the sinking of others, but much more, to the Desire of the Homogeneous Bodies to meet and unite. This Motion differs from that of *Need* in two points: 1st, because the latter is the stimulus of a malignant and contrary Nature; whilst in this of which we treat (if there be no impediment or restraint), the parts are united by their Affinity, although there be no foreign Nature to create a struggle; 2dly, because the union is closer and more select. For, in the other Motion, Bodies which have no great affinity unite, if they can but avoid the hostile Body, whilst in this, Substances which are connected by a decided kindred resemblance come together and are moulded into one. It is a Motion existing in all Compound Bodies, and would be readily seen in each, if it were not confined and checked by the other Affections and Necessities of Bodies which disturb the Union.

This Motion is usually confined in the three following manners: by the Torpor of the Bodies; by the Power of the Predominating Body; by external Motion. With regard to the first, it is certain that there is more or less Sluggishness in tangible Bodies, and an Abhorrence of Locomotion: so that unless excited they prefer remaining contented with their actual state, to placing themselves in a better position. There are three Means of breaking through this Sluggishness; Heat; the active Power of a Similar Body; vivid and powerful Motion. With regard to the first, Heat is, on this account, defined as that which *separates Heterogeneous and draws together Homogeneous Substances;* a Definition of the Peripatetics, which is justly ridiculed by *Gilbert*, who says it is as if one were to define Man, to be that which sows Wheat and plants Vineyards; being only a Definition deduced from Effects, and those but partial. But it is still more to be blamed, because those Effects, such as they are, are not a peculiar property of Heat, but a mere accident (for Cold, as we shall afterwards show, does the same), arising from the desire of the Homogeneous parts to unite; the Heat then assists them in breaking through that Sluggishness which before restrained their desire. With regard to the Assistance derived from the Power of a Similar Body, it is most conspicuous in the Magnet when armed with Steel, for it excites in the Steel a power of adhering to Steel, as a homogeneous substance, the Power of the Magnet breaking through the Sluggishness of the Steel. With regard to the Assistance of Motion it is seen in wooden arrows or points, which penetrate more deeply into wood, than if they were tipped with Iron, from the *simil* the substance, the swiftness of the Motion breaking through the Sluggishness of the Wood ; of which two last Experiments we have spoken above in the Aphorism on *Clandestine Instances.*[1]

The Confinement of the Motion of *Lesser Congregation*, which arises from the Power of the Predominant Body, is shown in the decomposition of Blood and Urine by Cold. For as long as these Substances are filled with the active spirit, which regulates and restrains each of their component parts, as the predominant Ruler of the Whole, the several Different Parts do not collect themselves separately on account of the Check ; but as soon as that Spirit has evaporated or has been choked by the Cold, then the decomposed Parts unite according to their natural desire. Hence it happens, that all Bodies which contain a sharp Spirit (as Salts and the like) last, without decomposition, owing to the permanent and durable Power of the predominating and imperious Spirit.

The Confinement of the Motion of *Lesser Congregation*, which arises from External Motion, is very evident in that Agitation of Bodies, which preserves them from putrefaction. For all Putrefaction depends on the Congregation of the Homogeneous Parts, whence, by degrees, there ensues a Corruption of the first Form (as it is called) and the Generation of another. For the Decomposition of the original Form, which is itself the Union of the Homogeneous Parts, precedes the Putrefaction, which prepares the way for the Generation of another. This Decomposition, if not interrupted, is simple, but if there be various obstacles, Putrefactions ensue, which are the rudiments of a new generation. But if (to come to our present point) a frequent agitation be excited, by External Motion, the Motion towards Union (which is delicate and gentle, and requires to be free from all external influence) is disturbed and ceases : which we perceive to be the case in innumerable instances.

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[1] See *Aphorism* 25.

Thus the daily agitation or flowing of Water prevents Putrefaction; Winds prevent the Air from being pestilent; Corn turned about and shaken in granaries continues clean: in short, every thing which is externally agitated will with difficulty rot internally.

We must not omit that Union of the Parts of Bodies which is the principal cause of Induration and Desiccation. When the Spirit or Moisture, which has evaporated into Spirit, has escaped from a porous Body (such as Wood, Bone, Parchment, and the like), the thicker Parts are drawn together, and united with a greater effort, and Induration or Desiccation is the consequence; and this we attribute not so much to the Motion of *connexion* (in order to prevent a Vacuum), as to this Motion of Friendship and Union.

Union from a distance is rare, and yet is to be met with in more instances than are generally observed. We perceive it when one Bubble dissolves another, when Medicines attract humours from a similarity of substance, when one String moves another in Unison with it on different instruments, and the like. We are of opinion that this Motion is very prevalent also in Animal Spirits, but are quite ignorant of the fact. It is, however, conspicuous in the Magnet, and magnetised Iron. Whilst speaking of the Motions of the Magnet, we must plainly distinguish them, for there are four distinct Powers or Effects of the Magnet which should not be confounded, although the wonder and astonishment of mankind has classed them together. 1. The Attraction of the Magnet to the Magnet, or of Iron to the Magnet, or of magnetised Iron to Iron. 2. Its Polarity towards the North and South, and its variation. 3. Its Penetration through Gold, Glass, Stone, and all other substances. 4. The Communication of Power from the Mineral to Iron, and from Iron to Iron, without any Communication of the substances. Here, however, we only speak of the first. There is also a singular Motion of Attraction, between Quicksilver and Gold, so that the Gold attracts Quicksilver even when made use of in ointment, and those who work surrounded by the vapours of Quicksilver are wont to hold a piece of Gold in their mouths, to collect the exhalations, which would otherwise attack their heads and bones, and this piece soon grows white.[1] Let this suffice for the Motion of *Lesser Congregation.*

Let the Ninth be the *Magnetic Motion*, which although of the nature of that last mentioned, yet, when operating at great Distances, and on great Masses, deserves a separate Inquiry, especially if it neither begin in Contact, as most Motions of Congregation do, nor end by bringing the substances into Contact, as all do, but only raise them, and make them swell without any further effect. For if the Moon raise the Waters, or cause Moist Substances to swell, or if the Starry Sphere attract the Planets towards their Apogees, or the Sun confine the Planets *Mercury* and *Venus* to within a certain Distance of his Mass;[2] these Motions do not appear capable of being classed under either of those of Congregation, but to be, as it were, *intermediately and imperfectly congregative*, and thus to form a distinct Species.

Let the Tenth Motion be that of *Avoidance*, or that which is opposed to the Motion of *Lesser Congregation*, by which Bodies, with a kind of Antipathy, avoid and disperse, and separate themselves from, or refuse to unite themselves with others of a hostile nature. For although this may sometimes appear to be an accidental Motion, necessarily attendant upon that of the *Lesser Congregation*, because the Homogeneous parts cannot unite, unless the Heterogeneous be first removed and excluded; yet it is still to be classed separately, and considered as a distinct Species, because, in many cases, the Desire of *Avoidance* appears to be more marked than that of Union.

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[1] Query.

[2] *Observe* this Approximation to *Newton*'s theory!

It is very conspicuous in the Excrements of Animals, nor less, perhaps, in Objects odious to particular Senses, especially the Smell and Taste. For a fetid Smell is rejected by the Nose, so as to produce a Sympathetic Motion of Expulsion at the Mouth of the stomach; a bitter and rough Taste is rejected by the Palate or Throat, so as to produce a Sympathetic concussion and shivering of the Head. This Motion is visible also in other cases. Thus it is observed in some kinds of Antiperistasis, as in the middle Region of the Air, the Cold of which appears to be occasioned by the Rejection of cold from the Regions of the Heavenly Bodies; and also in the heat and combustion observed in subterranean spots, which appear to be owing to the Rejection of heat from the centre of the Earth. For Heat and Cold, when in small Quantities, mutually destroy each other, whilst in larger Quantities, like armies equally matched, they remove and eject each other in open Conflict. It is said, also, that Cinnamon and other Perfumes retain their odour longer when placed near privies and foul places, because they will not unite and mix with stinks. It is well known that Quicksilver, which would otherwise reunite into a complete Mass, is prevented from so doing by man's spittle, pork Lard, Turpentine, and the like, from the little Affinity of its parts with those Substances, so that when surrounded by them it draws itself back, and its *Avoidance* of these intervening obstacles is greater than its desire of reuniting itself to its homogeneous parts; which is what they term the *Mortification* of Quicksilver. Again, the difference in Weight of Oil and Water is not the only Reason for their refusing to Mix, but it is also owing to the little Affinity of the two; for Spirits of wine, which are lighter than Oil, mix very well with Water. A very remarkable instance of the Motion in question is seen in Nitre, and crude Bodies of a like nature, which abhor Flame, as may be observed in gunpowder, Quicksilver, and Gold. The *Avoidance* of one pole of the Magnet by iron is not (as *Gilbert* has well observed), strickly speaking, an *Avoidance*, but a Conformity, or Attraction to a more convenient situation.

Let the Eleventh Motion be that of *Assimilation*, or self Multiplication, or *simple Generation*, by which latter term we do not mean the simple generation of Integral Bodies, such as Plants or Animals, but of homogeneous Bodies. By this Motion homogeneous Bodies convert those which are allied to them, or at least well disposed and prepared, into their own Substance and Nature. Thus Flame multiplies itself over vapours and oily substances, and generates fresh Flame; the Air over Water and Watery Substances multiplies itself and generates fresh Air; the Vegetable and Animal Spirit, over the thin particles of a Watery or Oleaginous Spirit contained in its food, multiplies itself and generates fresh Spirit; the solid parts of plants and Animals, as the Leaf, Flower, the Flesh, Bone, and the like, each of them assimilate some part of the Juices contained in their food, and generate a successive and daily substance. For let none rave with *Paracelsus*, who (blinded by his distillations) would have it, that Nutrition takes place by mere separation, and that the Eye, Nose, Brain, and Liver lie concealed in Bread and Meat, the Root, Leaf, and Flower in the juice of the Earth; asserting that just as the Artist brings out a Leaf, Flower, Eye, Nose, Hand, Foot, and the like, from a rude Mass of stone or wood by the Separation and Rejection of what is superfluous; so the great *Artist* within us brings out our several limbs and parts by Separation and Rejection. But to leave such trifling, it is most certain that all the parts of Vegetables and Animals, as well the homogeneous as Organic, first of all attract those juices contained in their food, which are nearly common, or at least not very different, and then assimilate and convert them into their own Nature. Nor does this *Assimilation*, or *simple Generation*, take place in

Animated Bodies only, but the Inanimate also participate in the same property (as we have observed of Flame and Air), and that languid Spirit, which is contained in every Tangible Animated Substance, is perpetually working upon the coarser parts, and converting them into Spirit, which afterwards is exhaled, whence ensues a diminution of weight, and a desiccation of which we have spoken elsewhere.[1] Nor should we, in speaking of *Assimilation*, neglect to mention the Accretion which is usually distinguished from Aliment, and which is observed when mud grows into a mass between stones, and is converted into a stony substance, and the scaly substance round the teeth is converted into one no less hard than the teeth themselves; for we are of opinion that there exists in all Bodies a desire of Assimilation, as well as of Uniting with Homogeneous Masses. Each of these powers, however, is confined, although in different manners, and should be diligently investigated, because they are connected with the revival of Old Age. Lastly, it is worthy of observation, that in the nine preceding Motions, Bodies appear to aim at the mere Preservation of their Nature, whilst in this they attempt its Propagation.

Let the Twelfth Motion be that of *Excitement*, which appears to be a species of the last, and is sometimes mentioned by us under that name. It is, like that, a Diffusive, Communicative, Transitive, and Multiplying Motion; and they agree remarkably in their Effect, although they differ in their mode of action, and in their subject matter. The former proceeds imperiously, and with authority; it orders and compels the Assimilated to be converted and changed into the Assimilating Body. The latter proceeds by Art, insinuation, and stealth, inviting and disposing the Excited towards the nature of the Exciting Body. The former both multiplies and transforms Bodies and substances; thus a Greater Quantity of Flame, Air,

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[1] See the Citing Instances, *Aphorism* xl.

Spirit, and Flesh is formed; but in the latter, the powers only are multiplied and changed, and Heat, the Magnetic Power, and Putrefaction, in the above instances, are increased. Heat does not diffuse itself when heating other bodies by any Communication of the original Heat, but only by *Exciting* the parts of the heated Body to that Motion which is the Form of Heat, and of which we spoke in the *first Vintage of the Nature of Heat.* Heat, therefore, is excited much less rapidly and readily in Stone or Metal, than in Air, on account of the inaptitude and sluggishness of those Bodies in acquiring that Motion, so that it is probable, that there may be some substances, towards the centre of the Earth, quite incapable of being heated, on account of their Density, which may deprive them of the spirit by which the Motion of *Excitement* is usually commenced. Thus also the Magnet creates in the Iron a new disposition of its parts, and a Conformable Motion without losing any of its Virtue. So the Leaven of Bread, Yeast, Rennet, and some poisons, excite and invite successive and continued Motion in Dough, Beer, Cheese, or the human Body; not so much from the power of the Exciting, as the predisposition and Yielding of the Excited Body.

Let the Thirteenth Motion be that of *Impression*, which is also a species of Motion of *Assimilation*, and the most subtle of Diffusive Motions. We have thought it right, however, to consider it as a distinct Species, on account of its remarkable difference from the two last. For the simple Motion of *Assimilation* transforms the Bodies themselves, so that if you remove the first Agent, you diminish not the effect of those which succeed; thus, neither the first lighting of Flame, nor the first conversion into Air, are of any importance to the Flame or Air next Generated. So, also, the Motion of *Excitement* still continues for a considerable time after the removal of the first agent, as in a heated Body on *the removal of* the original Heat, in the excited Iron on the removal of the Magnet, and in the Dough on the removal of the Leaven. But the Motion of *Impression*, although Diffusive and Transitive, appears, nevertheless, to depend on the first Agent, so that upon the removal of the latter the former immediately fails and perishes; for which reason also it takes effect in a moment, or at least a very short space of time. We are wont to call the two former motions the *Motions of the Generation of Jupiter*, because when born they continue to exist; and the latter, the *Motion of the Generation of Saturn*, because it is immediately devoured and absorbed. It may be seen in three instances; 1. in the rays of Light; 2. in the percussions of Sounds; 3. in Magnetic attractions as regards Communication. For, on the Removal of Light, Colours and all its other Images disappear, as on the Cessation of the first percussion and the vibration of the Body, sound soon fails, and although Sounds are agitated by the wind, like Waves, yet it is to be observed, that the same Sound does not last during the whole time of the Reverberation. Thus, when a Bell is struck, the Sound appears to be continued for a considerable time, and one might easily be led into the mistake of supposing it to float and remain in the Air during the whole time, which is most erroneous. For the Reverberation is not one identical Sound, but the Repetition of Sounds; which is made manifest by Stopping and Confining the sonorous Body; thus, if a Bell be stopped and held tightly, so as to be immovable, the Sound fails, and there is no further reverberation, and if a musical string be touched after the first vibration, either with the finger (as in the Harp), or a quill (as in the Harpsichord), the Sound immediately ceases. If the Magnet be removed the Iron falls. The Moon, however, cannot be removed from the Sea, nor the Earth from a Heavy falling Body, and we can, therefore, make no Experiment upon them, but the case is the same.

Let the Fourteenth Motion be that *Configuration* or *Position*, by which Bodies appear to desire a peculiar Situation, Collocation, and *Configuration* with others, rather than Union or Separation. This is a very abstruse notion, and has not been well Investigated; and, in some instances, appears to occur almost without any cause, although we be mistaken in supposing this to be really the case. For if it be asked, why the Heavens revolve from East to West, rather than from West to East, or why they turn on Poles situate near the *Bears*, rather than round *Orion* or any other part of the Heaven, such a question appears to be unreasonable, since these phenomena should be received as Determinate and the Objects of our Experience. There are, indeed, some ultimate and self-existing phenomena in Nature, but those which we have just mentioned are not to be referred to that class: for we attribute them to a certain Harmony and Consent of the Universe, which has not yet been properly observed. But if the Motion of the Earth from West to East be allowed, the same Question may be put, for it must also revolve round certain Poles, and why should they be placed where they are, rather than elsewhere? The Polarity and Variation of the Needle come under our present head. There is also observed in both Natural and Artificial Bodies, especially Solids rather than Fluids, a particular Collocation and Position of parts, resembling Hairs or Fibres, which should be diligently investigated, since, without a discovery of them, Bodies cannot be conveniently controlled or wrought upon. The Eddies observable in Liquids by which, when Compressed, they successively raise different parts of their mass before they can escape, so as to equalize the pressure, is more correctly assigned to the Motion of *Liberty*.

Let the Fifteenth Motion be that of *Transmission*, or of *Passage*, by which the Powers of Bodies are more or less impeded or advanced by the Medium, according to

Nature of the Bodies and their Effective Powers, and also according to that of the Medium. For one Medium is adapted to Light, another to Sound, another to Heat and Cold, another to Magnetic Action, and so on with regard to the other actions.

Let the Sixteenth be that which we term the *Royal* or *Political* motion, by which the Predominant and Governing Parts of any Body check, subdue, reduce, and regulate the others, and force them to unite, separate, stand still, move, or assume a certain position, not from any inclination of their own, but according to a certain Order, and as best suits the convenience of the Governing Part, so that there is a sort of *Dominion* and *Civil Government* exercised by the Ruling Part over its Subjects. The Motion is very conspicuous in the Spirits of Animals, where, as long as it is in force, it tempers all the Motions of the other parts. It is found in a less degree in other Bodies, as we have observed in Blood and Urine, which are not decomposed until the Spirit, which mixed and retained their parts, has been emitted or extinguished. Nor is this Motion peculiar to Spirits only, although in most Bodies the Spirit predominates, owing to its rapid Motion and penetration; for the grosser Parts predominate in denser Bodies, which are not filled with a quick and active Spirit (such as exists in Quicksilver or Vitriol), so that unless this check or yoke be thrown off by some contrivance, there is no hope of any transformation of such Bodies. And let not any one suppose that we have forgotten our subject, because we speak of *Predominance* in this Classification of Motions, which is made entirely with the view of assisting the investigation of *Wrestling Instances*, or *Instances of Predominance*. For we do not now treat of the general *Predominance* of *Motions* or *Powers*, but of that of Parts in whole Bodies, which constitutes the particular Species here considered.

Let the Seventeenth Motion be the *spontaneous Motion* of *Revolution*, by which Bodies having a tendency to Move, and placed in a favourable situation, enjoy their peculiar Nature, pursuing themselves and nothing else, and seeking as it were to embrace themselves. For Bodies seem either to move without any Limit, or to tend towards a Limit, arrived at which they either revolve according to their peculiar Nature, or rest. Those which are favourably situated, and have a tendency to Motion, move in a Circle with an eternal and unlimited Motion; those which are favourably situated and abhor motion, rest. Those which are not favourably situated move in a straight line (as their shortest path), in order to unite with others of a Congenial Nature. This Motion of *Revolution* admits of nine Differences; 1. with regard to the Centre about which the Bodies move; 2. the Poles round which they move; 3. the Circumference or Orbit relatively to its distance from the Centre; 4. the Velocity or greater or less speed with which they revolve; 5. the Direction of the Motion as from East to West, or the reverse; 6. the Deviation from a perfect Circle, by Spiral Lines at a greater or less distance from the Centre; 7. the Deviation from the Circle, by Spiral Lines at a greater or less distance from the Poles; 8. the greater or less Distance of these Spirals from each other; 9. and lastly, the Variation of the Poles if they be movable; which however, only affects Revolution when circular. The Motion in question is, according to common and long received opinion, considered to be that of the Heavenly Bodies. There exists, however, with regard to this, a considerable Dispute between some of the Ancients as well as Moderns, who have attributed a Motion of *Revolution* to the Earth. A much more reasonable Controversy, perhaps, exists (if it be not a matter beyond Dispute), whether the Motion in question (on the hypothesis of the Earth's being fixed) is confined to the Heavens, or rather descends and is communicated to the Air and Water. The Rotation of

Missiles, as in Darts, Musket Balls, and the like, we refer entirely to the Motion of *Liberty*.

Let the Eighteenth Motion be that of *Trepidation*, to which (in the sense assigned to it by Astronomers) we do not give much credit; but in our serious and general search after the Tendencies of Natural Bodies, this Motion occurs and appears worthy of forming a distinct species. It is the Motion of an (as it were) eternal Captivity; when Bodies, for instance, being placed not altogether according to their Nature, and yet not exactly ill, constantly tremble, and are restless, not contented with their position, and yet not daring to advance. Such is the Motion of the Heart and pulse of Animals, and it must necessarily occur in all Bodies which are situated in a mean state, between Conveniences and Inconveniences; so that being removed from their proper position, they strive to escape, are repulsed, and again continue to make the attempt.

Let the Nineteenth and last Motion be one which can scarcely be termed a Motion, and yet is one; and which we may call the *Motion of Repose*, or of *Abhorrence of Motion*. It is by this Motion that the Earth stands by its own weight, whilst its Extremes move towards the Middle, not to an Imaginary Centre, but in order to Unite. It is owing to the same Tendency, that all Bodies of considerable Density abhor Motion, and their only Tendency is not to move, which Nature they preserve although excited and urged in a variety of ways to Motion. But if they be compelled to move, yet do they always appear anxious to recover their former state, and to cease from motion, in which respect they certainly appear active, and attempt it with sufficient swiftness and rapidity, as if fatigued and impatient of Delay. We can only have a partial Representation of this Tendency, because with us every Tangible substance is not only not Condensed to the Utmost, but even some Spirit is added, owing to *the Action* and Concocting influence of the Heavenly Bodies.

We have now, therefore, exhibited the Species or Simple Elements of the Motions, Tendencies, and Active Powers, which are most Universal in Nature ; and no small portion of Natural Science has been thus sketched out. We do not, however, deny that other Instances can perhaps be added, and our Divisions changed according to some more natural order of things, and also reduced to a less number ; in which respect we do not allude to any abstract classification, as if one were to say, That Bodies desire the Preservation, Exaltation, Propagation, or Fruition of their Nature ; or, That Motion tends to the Preservation and Benefit either of the Universe (as in the case of those of *Resistance* and *Connexion*), or of extensive Wholes as in the case of those of the *Greater Congregation*, *Revolution*, and *Abhorrence of Motion*, or of particular Forms, as in the case of the others. For although such remarks be just, yet unless they terminate in Matter and Construction, according to true definitions, they are speculative and of little use. In the mean time our classification will suffice, and be of much use in the consideration of the *Predominance* of Powers, and examining the *Wrestling Instances* which constitute our present subject.

For of the Motions here laid down some are quite Invincible, some more powerful than others, which they confine, check, and modify ; others extend to a greater distance, others are more immediate and swift, others strengthen, increase, and accelerate the rest.

The Motion of *Resistance* is most Adamantine and Invincible. We are yet in doubt whether such be the nature of that of *Connexion ;* for we cannot with certainty determine whether there be a Vacuum, either Extensive or Intermixed with Matter. Of one thing, however, we are satisfied, that the Reason assigned by *Leucippus* and *Democritus* for the introduction of a Vacuum (namely, that the same Bodies could *not* otherwise comprehend and fill greater and less spaces) is false. For there is clearly a *Folding of Matter*, by which it wraps and unwraps itself in space within certain limits, without the intervention of a Vacuum. Nor is there two thousand times more of Vacuum in Air than in Gold, as there should be on this hypothesis; a fact demonstrated by the very Powerful energies of Fluids (which would otherwise float like fine dust in Vacuo), and many other Proofs. The other Motions direct and are directed by each other according to their Strength, Quantity, Excitement, Emission, or the Assistance or Impediments they meet with.

For instance; some armed Magnets hold and support Iron of Sixty Times their own weight; so far does the Motion of *Lesser Congregation* predominate over that of the *Greater;* but if the Weight be increased it yields. A Lever of a certain strength will raise a given weight, and so far the Motion of *Liberty* predominates over that of the *Greater Congregation*, but if the Weight be greater the former motion yields. A piece of Leather stretched to a certain point does not break, and so far the Motion of *Continuity* predominates over that of Tension, but if the Tension be greater the Leather breaks, and the Motion of *Continuity* yields. A certain quantity of Water flows through a Chink, and so far the Motion of *Greater Congregation* predominates over that of *Continuity*, but if the Chink be smaller it yields. If a Musket be charged with Ball and Powdered Sulphur alone, and fire be applied, the Ball is not discharged, in which case the Motion of *Greater Congregation* overcomes that of *Matter*, but when Gunpowder is used the Motion of *Matter* in the Sulphur predominates, being assisted by that Motion and the Motion of *Avoidance* in the Nitre; and so of the rest. For *Wrestling Instances* (which show the *Predominance* of Powers, and in what manner and proportion they predominate and yield) must be searched for with active and industrious diligence.

The Methods and Nature of this Yielding must also be diligently examined, as for instance, whether the motions completely cease or exert themselves but are constrained. For in the Bodies with which we are acquainted, there is no real but an apparent Rest, either in the Whole or in Parts. This apparent Rest is occasioned either by *Equilibrium* or the absolute *Predominance* of Motions. By *Equilibrium*, as in the Scales of the Balance, which rest if the weights be equal. By *Predominance*, as in perforated Jars, in which the Water rests, and is prevented from falling by the *Predominance* of the Motion of *Connexion*. It is, however, to be observed (as we have said before), how far the Yielding Motions exert themselves. For if a man be held stretched out on the ground against his will, with arms and legs bound down, or otherwise confined, and yet strive with all his power to get up, the Struggle is not the less although ineffectual. The real state of the case (namely, whether the Yielding Motion be, as it were, annihilated by the *Predominance*, or there be rather a continued although an invisible Effort) will perhaps appear in the Concurrence of motions, although it escape our notice in their Conflict. For instance; let an Experiment be made with Muskets; whether a Musket-Ball, at its utmost range in a straight line, or (as it is commonly called) Point Blank, strike with less force when projected upwards, where the Motion of the Blow is simple, than when projected downwards, where the Motion of Gravity concurs with the Blow.

The Rules of such *Instances of Predominance* as occur should be collected: such as the following; the more General the desired Advantage is, the stronger will be the Motion; the Motion of *Connexion*, for instance, which relates to the Intercourse of the parts of the Universe, is more powerful than that of Gravity, which relates to the Intercourse of Dense Bodies only. Again, the Desire of a Private Good does not in general prevail against that of a

Public one, except where the Quantities are small. Would that such were the case in Civil Matters !

xlix. In the Twenty-fifth rank of Prerogative Instances we will place *Suggesting Instances ;* such as suggest or point out that which is Advantageous to mankind ; for bare *Power* and *Knowledge* in themselves exalt rather than enrich human Nature. We must, therefore, select from the General Store such things as are most useful to mankind. We shall have a better opportunity of discussing these when we treat of the *application to practice ;* besides, in the Work of *Interpretation*, we leave room, on every subject, for the *human* or *Optative Chart ;* for it is a part of Science to make judicious Inquiries and Wishes.

l. In the Twenty-sixth rank of *Prerogative Instances* we will place the *generally Useful Instances.* They are such as relate to various points, and frequently occur, sparing by that means considerable labour and new trials. The proper place for treating of Instruments and Contrivances will be that in which we speak of the Application to practice, and the Methods of Experiment. All that has hitherto been ascertained, and made use of, will be described in the Particular History of each Art. At present we will subjoin a few General Examples of the *Instances* in question.

Man acts, then, upon Natural Bodies (besides merely bringing them together or removing them) by seven principal methods : 1. By the Exclusion of all that impedes and disturbs ; 2. By Compression, Extension, Agitation, and the like ; 3. By Heat and Cold ; 4. By Detention in a suitable place ; 5. By Checking or Directing Motion ; 6. By peculiar Harmonies ; 7. By a seasonable and proper Alternation, Series, and Succession of all these, or at least of some of them.

I. With regard to the First ; common Air, which is always at hand, and forces its admission, as also the Rays of the Heavenly Bodies, create much disturbance. Whatever, therefore, tends to Exclude them, may well be considered as *generally Useful.* The Substance and Thickness of Vessels in which Bodies are placed when prepared for Operations may be referred to this head. So, also, may the accurate Methods of Closing Vessels by Consolidation, or the *Lutum sapientiæ* as the Chymists call it. The Exclusion of Air by means of Liquids at the Extremity is also very useful; as when they pour oil on wine, or the juices of herbs, which, by spreading itself upon the top like a cover, preserves them uninjured from the Air. Powders, also, are serviceable, for although they contain Air mixed up in them, yet they ward off the power of the mass of circumambient Air, which is seen in the preservation of grapes, and other fruits, in sand or flour. Wax, Honey, Pitch, and other resinous bodies, are well used in order to make the Exclusion more perfect, and to remove the Air and Celestial Influence. We have sometimes made an Experiment, by placing a Vessel or other Bodies in Quicksilver, the most dense of all substances capable of being poured round others. Grottos and subterraneous Caves are of great use in keeping off the Effects of the Sun, and the predatory action of Air, and in the North of *Germany* are used for Granaries. The Depositing of Bodies at the bottom of Water may be also mentioned here, and I remember having heard of some Bottles of wine being let down into a deep well in order to cool them, but left there by chance, carelessness, and forgetfulness for several years, and then taken out; by which means the Wine not only escaped becoming flat or dead, but was much more excellent in flavour; arising (as it appears) from a more complete mixture of its parts. But if the case require that Bodies should be sunk to the bottom of Water, as in Rivers, or the Sea, and yet should not touch the Water, nor be inclosed in sealed Vessels, but surrounded only by Air, it would be right to use that Vessel which *has been* sometimes employed under Water ab

Ships that have sunk, in order to enable the Divers to remain below and breathe occasionally by turns. It was of the following nature. A hollow Tub of Metal was formed, and sunk so as to have its bottom parallel with the surface of the Water; it thus carried down with it to the bottom of the Sea all the air contained in the Tub. It stood upon three feet (like a Tripod), being of rather less Height than a man, so that when the Diver was in want of breath, he could put his head into the hollow of the Tub, breathe, and then continue his work. We hear that some sort of Boat or Vessel has now been invented, capable of carrying men some distance under Water. Any Bodies, however, can easily be suspended under some such Vessel as we have mentioned, which has occasioned our remarks upon the Experiment.

Another advantage of the careful and hermetical Closing of Bodies is this; not only the admission of external Air is prevented (of which we have treated), but the Spirit of Bodies also is prevented from making its escape, which is an internal operation. For any one operating on Natural Bodies must be certain as to their Quantity, and that nothing has evaporated or escaped; since profound alterations take place in bodies, when art prevents the loss or escape of any portion, whilst Nature prevents their Annihilation. With regard to this circumstance, a false idea has prevailed (which if true would make us despair of preserving Quantity without diminution), namely, that the Spirit of Bodies, and Air when rarefied by a great degree of heat, cannot be so kept in by being enclosed in any Vessel, as not to escape by the small pores. Men are led into this idea by the common Experiments of a Cup inverted over Water, with a Candle or piece of lighted Paper in it, by which the Water is drawn up, and of those cups which when heated draw up the flesh. For they think that in each *Experiment* the rarefied Air escapes, and that its *Quantity* is therefore diminished, by which means the Water or Flesh rises by the Motion of *Connexion*. This is, however, most incorrect. For the Air is not diminished in *Quantity*, but contracted in dimensions,[1] nor does this Motion of the rising of the Water begin till the Flame is extinguished, or the Air cooled, so that Physicians place cold sponges, moistened with water, on the cups, in order to increase their attraction. There is, therefore, no reason why men should fear much from the ready escape of Air: for although it be true that the most solid Bodies have their pores, yet neither Air, nor Spirit, readily suffers itself to be rarefied to such an extreme degree; just as Water will not escape by a small chink.

II. With regard to the Second of the seven above mentioned Methods, we must especially observe, that Compression and similar Violence have a most powerful effect either in producing Locomotion, and other motions of the same nature, as may be observed in Engines and Projectiles, or in destroying the Organic Body and those Qualities which consist entirely in Motion (for all life, and every description of Flame and Ignition are destroyed by Compression, which also injures and deranges every Machine); or in destroying those Qualities which consist in Position and a coarse difference of parts, as in Colours; for the colour of a Flower when whole differs from that it presents when bruised, and the same may be observed of whole and powdered Amber; or in Tastes, for the taste of a Pear before it is ripe and of the same pear when bruised and softened is different, since it becomes perceptibly more sweet. But such Violence is of little avail in the more noble transformations and changes of Homogeneous Bodies, for they do not, by such means, acquire any constantly and permanently new state, but one that is transitory, and always struggling to return to its former habit and freedom. It would not, however, be useless to make some more diligent Experiments with regard to this; whether, for instance, the Condensation of a perfectly Homogeneous Body (such as Air, Water, Oil, and the like) or their Rarefaction, when effected by violence, can become permanent, fixed, and as it were so changed as to become a Nature. This might at first be tried by simple Perseverance, and then by means of Helps and Harmonies. It might readily have been attempted (if we had but thought of it), when we condensed Water (as was mentioned above) by hammering and compression until it burst out. For we ought to have left the flattened Globe untouched for some days, and then to have drawn off the Water in order to try whether it would have immediately occupied the same dimensions as it did before the condensation. If it had not done so, either immediately, or soon afterwards, the condensation would have appeared to have been rendered constant, if not, it would have appeared that a Restitution took place, and that the Condensation had been transitory. Something of the same kind might have been tried with the glass Eggs; the Egg should have been Sealed up suddenly and firmly, after a complete exhaustion of the Air, and should have been allowed to remain so for some days, and it might then have been tried whether, on opening the aperture, the air would be drawn in with a hissing noise, or whether as much Water would be drawn into it when immersed, as would have been drawn into it at first, if it had not continued sealed. For it is probable (or at least worth making the experiment) that this might have happened, or might happen, because perseverance has a similar effect upon Bodies which are a little less homogeneous. A Stick bent together for some time does not rebound, which is not owing to any loss of

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[1] Part of the Air is expanded and escapes, and part is consumed by the Flame. When condensed, therefore, by the cold application, it cannot offer sufficient resistance to the external Atmosphere to prevent the liquid or flesh from being forced into the Glass.

Quantity in the Wood during the Time, for the same would occur (after a larger time) in a plate of Steel, which does not evaporate. If the Experiment of simple Perseverance should fail, the matter should not be given up, but other Means should be employed. For it would be no small advantage, if Bodies could be endued with fixed and constant Natures by violence. Air could then be converted into Water by Condensation, with other similar effects; for Man is more the Master of Violent Motions than of any other means.

III. The Third of our seven Methods is referred to that great practical Engine of Nature as well as of Art, Cold, and Heat. Here man's Power limps, as it were, with one leg. For we possess the Heat of fire, which is infinitely more powerful and intense than that of the Sun (as it reaches us), and that of Animals. But we want Cold,[1] except such as we can obtain in winter, in Caverns, or by Surrounding Objects with Snow and Ice, which, perhaps, may be Compared in degree with the noontide Heat of the Sun in Tropical Countries, increased by the reflection of Mountains and Walls. For this degree of Heat and Cold can be borne for a short Period only by Animals, yet it is nothing compared with the Heat of a burning Furnace, or the corresponding degree of Cold.[2] Every thing with us has a tendency to become Rarefied, Dry, and Wasted, and nothing to become Condensed or Soft, except by Mixtures, and, as it were, spurious Methods. Instances of Cold, therefore, should be searched for most diligently, such as may by found by Exposing Bodies upon Buildings in a hard frost, in subterraneous Caverns, by surrounding Bodies with Snow and Ice in deep places excavated for that purpose, by letting Bodies down into wells, by Burying Bodies in Quicksilver and Metals, by Immersing them in Streams which petrify Wood, by Burying them in the Earth (which the *Chinese* are reported to do with their China, Masses of which, made for that purpose, are said to remain in the ground for forty or fifty Years, and to be transmitted to their heirs as a sort of artificial Mine), and the like. The Condensations which take place in Nature by means of Cold should also be investigated, that by learning their Causes they may be introduced into the Arts; such as are observed in the exudation of Marble and Stones, in the Dew upon the Panes of Glass in a room towards Morning after a frosty Night, in the Formation and the Gathering of Vapours under the Earth into Water, whence spring Fountains, and the like.

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[1] Heat can now be abstracted by a very simple process, till the degree of Cold be of almost any required Intensity.

[2] It is impossible to compare a degree of Heat with a degree of Cold, without the assumption of some arbitrary test, to which the degrees are to be referred. In the next sentence *Bacon* appears to have taken the power of animal Life to support Heat or Cold as the test, and then the comparison can only be between the degree of Heat or of Cold that will produce Death.

The Zero must be arbitrary which divides equally a certain degree of *Heat from a certain* degree of Cold.

Besides the substances which are Cold to the Touch, there are others which have also the effect of Cold, and Condense; they appear, however, to act only upon the Bodies of Animals, and scarcely any further. Of these we have many instances, in Medicines and Plasters. Some Condense the Flesh and tangible Parts, such as Astringent and Inspissating Medicines, others the Spirits, such as Soporifics. There are two Modes of Condensing the Spirits, by Soporifics or provocatives to Sleep; the one by calming the Motion, the other by Expelling the Spirit. The Violet, dried Roses, Lettuces, and other benign or mild Remedies, by their friendly and gently cooling vapours, invite the Spirits to unite, and restrain their violent and perturbed Motion. Rosewater, for instance, applied to the Nostrils in fainting fits, causes the resolved and relaxed Spirits to recover themselves, and, as it were, cherishes them. But Opiates, and the like, banish the Spirits by their malignant and hostile quality. If they be applied, therefore, externally, the Spirits immediately quit the part and no longer readily flow into it; but if they be taken internally, their Vapour, mounting to the Head, expels in all directions, the Spirits contained in the Ventricles of the Brain, and since these Spirits retreat, but cannot escape, they Consequently meet and are condensed, and are sometimes completely extinguished and suffocated; although the same Opiates, when taken in moderation, by a secondary accident (the Condensation which succeeds their Union), strengthen the Spirits, render them more robust, and check their useless and imflammatory Motion, by which means they contribute not a little to the Cure of Diseases, and the Prolongation of Life.

The Preparations of Bodies, also, for the reception of Cold should not be omitted, such as that Water a little warmed is more easily frozen than that which is quite cold, and the like.

Moreover, since Nature supplies Cold so sparingly, we must act like the Apothecaries, who, when they cannot obtain any simple ingredient, take a Succedaneum, or *Quid* pro *Quo*, as they term it, such as Aloes for Xylobalsamum, Cassia for Cinnamon. In the same manner we should look diligently about us, to ascertain whether there may be any Substitutes for Cold, that is to say, in what other Manner Condensation can be effected, which is the peculiar Operation of Cold. Such Condensations appear hitherto to be of four kinds only. 1. By simple Compression, which is of little avail towards permanent Condensation, on account of the elasticity of Substances, but may still however be of some assistance. 2. By the Contraction of the coarser, after the escape or departure of the finer parts of a given Body; as is exemplified in Induration by Fire, and the repeated heating and Extinguishing of Metals, and the like. 3. *By the Cohesion* of the most solid homogeneous p a given Body, which were previously separated, and mixed with others less solid, as in the Return of Sublimated Mercury to its simple state, in which it occupies much less space than it did in powder, and the same may be observed of the Cleansing of all Metals from their Dross. 4. By Harmony or the application of Substances which condense by some latent power. These Harmonies are as yet but rarely observed, at which we cannot be surprised, since there is little to hope for from their Investigation, unless the Discovery of Forms and Conformation be attained. With regard to Animal Bodies, it is not to be questioned that there are many internal and external Medicines which condense by Harmony, as we have before observed, but this Action is rare in Inanimate Bodies. Written Accounts, as well as report, have certainly spoken of a Tree in one of the *Tercera* or *Canary Islands* (for I do not exactly recollect which) that drips perpetually, so as to supply the Inhabitants, in some degree, with Water; and *Paracelsus* says that the Herb called *Ros Solis* is filled with dew at Noon, whilst the sun gives out its greatest heat, and all other Herbs around it are dry. We treat both these Accounts as fables; they would however, if true, be of the most important service, and most worthy of examination. As to the Honey-Dew, resembling Manna, which is found in May on the leaves of the Oak, we are of opinion that it is not condensed by any Harmony or Peculiarity of the Oak Leaf, but that whilst it falls equally upon other Leaves it is retained and continues on those of the Oak, because their texture is closer, and not so porous as that of most of the other leaves.[1]

With regard to Heat, man possesses Abundant Means and Power; but his Observation and Inquiry are defective in some respects, and those of the greatest importance, notwithstanding the boasting of Quacks. For the Effects of

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[1] It may often be observed on the leaves of the Lime and other *trees.*

Intense Heat are Examined and Observed, whilst those of a more gentle degree of heat, being of the most frequent occurrence in the paths of Nature, are, on that very account, least known. We see, therefore, the Furnaces, which are most esteemed, employed in increasing the Spirits of Bodies to a great extent, as in the strong Acids, and some Chymical Oils; whilst the tangible parts are hardened, and, when the Volatile part has escaped, become sometimes fixed; the homogeneous parts are separated, and the heterogeneous incorporated and agglomerated in a coarse lump; and (what is chiefly worthy of remark) the Junction of Compound Bodies, and the more delicate Conformations are destroyed and confounded. But the Operation of a less violent Heat should be tried and investigated, by which more delicate Mixtures, and regular Conformations may be produced and elicited, according to the Example of Nature, and in Imitation of the Effect of the Sun, which we have alluded to in the Aphorism on the Instances of *Alliance*. For the Works of Nature are carried on in much smaller portions, and in more delicate and varied positions than those of Fire, as we now employ it. But Man will then appear to have really augmented his Power, when the Works of Nature can be imitated *in Specie*, perfected in Power, and varied in quantity; to which should be added the Acceleration in point of Time. Rust, for instance, is the result of a long process, but Crocus Martis is obtained immediately; and the same may be observed of natural Verdigris and Ceruse. Crystal is formed slowly, whilst Glass is blown immediately: Stones increase slowly, whilst Bricks are baked immediately, &c. In the mean time (with regard to our present subject) every different species of Heat should, with its peculiar Effects, be diligently collected and inquired into; that of the Heavenly Bodies, whether their rays be direct, reflected, or refracted, or condensed by a Burning Glass; that of *Lightning, Flame*, and Ignited Charcoal; that of Fire different Materials, either open or confined, straitened or overflowing, qualified by the different forms of the Furnaces, excited by the bellows, or quiescent, removed to a Greater or Less Distance, or passing through different Media; moist Heats, such as the Balneum Mariæ, and the Dunghill; the external and internal Heat of Animals; dry Heats, such as the heat of Ashes, Lime, warm Sand; in short, the nature of every kind of Heat, and its degrees.

We should, however, particularly attend to the Investigation and Discovery of the Effects and Operations of Heat, when made to Approach and Retire by degrees, regularly, periodically, and by proper intervals of space and time. For this systematical Inequality is in truth the Daughter of Heaven and Mother of Generation, nor can any great result be expected from a vehement, precipitate, or desultory Heat. For this is not only most evident in vegetables, but in the Wombs of Animals also there arises a great Inequality of Heat, from the Motion, Sleep, Food, and Passions of the Female. The same Inequality prevails in those Subterraneous Beds where Metals and Fossils are perpetually forming, which renders yet more remarkable the Ignorance of some of the Reformed Alchymists, who imagined they could attain their object by the equable Heat of Lamps, or the like, burning uniformly. Let this suffice concerning the Operation and Effects of Heat; nor is it time for us to investigate them thoroughly before the Forms and Conformations of Bodies have been further examined and brought to light. When we have determined upon our Models, we may seek, apply, and arrange our Instruments.

IV. The fourth Mode of action is by Continuance, the very Steward and Almoner, as it were, of Nature. We apply the term Continuance to the abandonment of a Body to itself for an observable time, guarded and protected in *the mean* while from all external force. For the internal

Motion then commences to betray and exert itself when the external and adventitious is removed. The effects of Time, however, are far more delicate than those of Fire. Wine, for instance, cannot be Clarified by Fire as it is by Continuance. Nor are the Ashes produced by Combustion so fine as the particles Dissolved or Wasted by the lapse of ages. The Incorporations and Mixtures, which are hurried by Fire, are very inferior to those obtained by Continuance; and the various Conformations assumed by Bodies left to themselves, such as mouldiness, &c. are put a stop to by Fire or a strong Heat. It is not, in the mean time, unimportant to remark that there is a certain degree of violence in the Motion of Bodies entirely Confined. For the Confinement impedes the proper Motion of the Body. Continuance in an open Vessel, therefore, is useful for Separations, and in one hermetically sealed for Mixtures, that in a Vessel partly closed, but admitting the Air, for Putrefaction. But instances of the Operation and Effect of Continuance must be collected diligently from every quarter.

V. The Direction of Motion (which is the Fifth Method of Action) is of no small use. We adopt this term, when speaking of a Body which meeting with another either arrests, repels, allows, or directs its original Motion. This is the case principally in the Figure and Position of Vessels. An upright Cone, for instance, promotes the Condensation of Vapour in Alembics, but when reversed, as in inverted vessels, it assists the Refining of Sugar. Sometimes a Curved Form or one alternately Contracted and Dilated are required. Strainers may be ranged under this head, where the Opposed Body opens a way for one portion of another substance and impedes the rest. Nor is this process or any other Direction of Motion carried on externally only, but sometimes by one Body within another. Thus, Pebbles are thrown into Water to collect the Muddy Particles, and Syrups are refined by the White of an which glues the grosser particles together so as to facilitate their removal. *Telesius*, indeed, rashly and ignorantly enough attributes the Formation of Animals to this cause, by means of the channels and folds of the Womb. He ought to have observed a similar formation of the Young in Eggs which have no wrinkles or inequalities. One may observe a real result of this Direction of Motion in Casting and Modelling.

VI. The Effects produced by Harmony and Aversion (which is the sixth Method) are frequently buried in obscurity. For these Occult and Specific Properties (as they are termed) the Sympathies and Antipathies are for the most part but a Corruption of Philosophy. Nor can we form any great expectation of the Discovery of the Harmony which exists between natural objects, before that of their Forms and simple Conformations, for it is nothing more than the Symmetry between these Forms and Conformations.

The Greater and more Universal Species of Harmony are not, however, so wholly obscure, and with them, therefore, we must commence. The first and principal distinction between them is this ; that some Bodies differ considerably in the Abundance and Rarity of their Substance, but correspond in their Conformation ; others, on the Contrary, Correspond in the former and differ in the latter. Thus the Chymists have well observed, that in their Trial of first principles Sulphur and Mercury, as it were, pervade the Universe ; their reasoning about Salt, however, is absurd, and merely introduced to comprise earthy dry fixed Bodies. In the other two, indeed, one of the most Universal Species of Natural Harmony manifests itself. Thus there is a Correspondence between Sulphur, Oil, greasy Exhalations, Flame, and, perhaps, the Substance of the Stars. On the other hand, there is a like Correspondence between Mercury, Water, Aqueous Vapour, Air, and perhaps, pure intersideral Æther. Yet do these two Quaternions, or Great natural Tribes (each within its own Limits) differ immensely in Quantity and Density of Substance, whilst they generally agree in Conformation, as is manifest in many instances. On the other hand, the Metals agree in such Quantity and Density (especially when compared with vegetables, &c.), but differ in many respects in Conformation. Animals and Vegetables, in like manner, vary in their almost infinite modes of Conformation, but range within very limited degrees of Quantity and Density of Substance.

The next most General Correspondence is that between individual Bodies and those which supply them by way of Menstruum or Support. Inquiry, therefore, must be made as to the Climate, Soil, and depth at which each Metal is generated, and the same of Gems whether produced in Rocks or Mines, also as to the soil in which particular Trees, Shrubs, and Herbs, mostly grow and, as it were, delight; and as to the best species of Manure, whether Dung, Chalk, Sea Sand, or Ashes, &c. and their different propriety and advantage according to the variety of soils. So also the Grafting and Setting of Trees and Plants (as regards the readiness of grafting one particular species on another) depends very much upon Harmony, and it would be amusing to try an Experiment I have lately heard of, in Grafting Forest Trees (garden Trees alone having hitherto been adopted), by which means the Leaves and Fruit are enlarged, and the Trees produce more shade. The specific Food of Animals again should be observed, as well as that which cannot be used. Thus the Carnivorous cannot be fed on herbs, for which reason the Order of *Feuilletans*, the experiment having been made, has nearly vanished; human Nature being incapable of supporting their regimen, although the human Will has more power over the Bodily Frame than that of other Animals. The different Kinds of Putrefaction from which Animals are generated should be noted

The Harmony of Principal Bodies with those Subordinate to them (such indeed may be deemed those we have alluded to above) are sufficiently manifest, to which may be added those that exist between different bodies and their Objects, and, since these latter are more apparent, they may throw great light when well observed and diligently examined upon those which are more latent.

The more Internal Harmony and Aversion, or Friendship and Enmity (for Superstition and folly have rendered the terms of Sympathy and Antipathy almost disgusting), have been either falsely Assigned, or mixed with Fable, or most Rarely discovered from neglect. For if one were to allege that there is an enmity between the Vine and the Cabbage, because they will not come up well when sown together, there is a sufficient reason for it in the succulent and absorbent nature of each Plant, so that the one defrauds the other. Again, if one were to say that there is a Harmony and Friendship between the Corn and the Corn-flower, or the Wild Poppy, because the latter seldom grow any where but in cultivated soils, he ought rather to say there is an enmity between them, for the Poppy and the Corn-flower are produced and created by those Juices which the Corn has left and rejected, so that the Sowing of the Corn prepares the ground for their production. And there are a vast number of similar false Assertions. As for Fables, they must be totally exterminated. There remains then but a scanty Supply of such species of Harmony as has borne the test of Experiment, such as that between the Magnet and Iron, Gold and Quicksilver, and the like. In Chymical Experiments on Metals, however, there are some others worthy of notice, but the greatest abundance (where the whole are so few in numbers) is discovered in certain Medicines, which, from their occult and specific qualities (as they are termed), affect particular Limbs, Humours, *Diseases,* or Constitutions. Nor should we omit the

Harmony between the Motion and Phenomena of the Moon, and their Effects on Lower Bodies, which may be brought together by an accurate and honest selection from the Experiments of Agriculture, Navigation, and Medicine, or of other sciences. By as much as these general Instances, however, of more latent Harmony, are rare, with so much the more diligence are they to be inquired after, through tradition, and faithful and honest reports, but without rashness and credulity, with an anxious and, as it were, hesitating degree of reliance. There remains one species of Harmony which, though Simple in its Mode of action, is yet most Valuable in its use, and must by no means be omitted, but rather diligently investigated. It is the ready or difficult coition or union of bodies in composition or simple juxtaposition. For some Bodies readily and willingly Mix and are Incorporated, others tardily and perversely; thus Powders mix best with Water, Chalk and Ashes with Oils, and the like. Nor are these Instances of *Readiness* and *Aversion* to Mixture to be alone collected, but others also of the Collocation, Distribution, and Digestion of the parts when mingled, and the Predominance after the Mixture is complete.

VII. Lastly, there remains the seventh and last of the seven Modes of Action; namely, that by the Alternation and Interchange of the other six; but of this it will not be the right time to offer any examples until some deeper investigation shall have taken place of each of the others. The Series or Chain of this Alternation, in its mode of application to separate Effects, is no less powerful in its Operation than difficult to be Traced. But men are possessed with the most extreme Impatience, both of such Inquiries and their Practical application, although it be the clue of the Labyrinth in all Greater Works. Thus far of the Generally Useful Instances.

li. The twenty-seventh and last place we will assign to the *Magical Instances*, a term which we apply to those where the Matter or Efficient Agent is scanty or small, in comparison with the grandeur of the Work or Effect produced; so that even when common they appear Miraculous, some at first sight, others even upon more attentive observation. Nature, however, of herself supplies these but sparingly. What she will do when her whole Store is thrown open, and after the Discovery of Forms, Processes, and Conformation, will appear hereafter. As far as we can yet conjecture, these Magic Effects are produced in three ways, either by self Multiplication, as in Fire, and the Poisons termed Specific, and the Motions transferred and Multiplied from Wheel to Wheel; or by the Excitement or, as it were, Invitation of another substance, as in the Magnet, which excites innumerable Needles without losing or diminishing its power, and again in leaven, and the like; or by the Excess of Rapidity of one species of motion over another, as has been observed in the case of Gunpowder, Cannon, and Mines. The two former require an Investigation of Harmonies, the latter of a Measure of Motion. Whether there be any Mode of changing bodies per minima (as it is termed) and transferring the delicate Conformations of Matter, which is of importance in all Transformations of Bodies, so as to enable Art to effect in a short time that which Nature works out by divers expedients, is a point of which we have as yet no Indication. But as we aspire to the extremest and highest Results in that which is Solid and True, so do we ever detest and, as far as in us lies, expel all that is Empty and Vain.

lii. Let this suffice as to the respective Dignity or *Prerogatives of Instances*. But it must be noted that in this our *Organ*, we treat of Logic and not of Philosophy. Seeing, however, that our Logic instructs and informs the Understanding, in order that it may not, with the small *Hooks*, as it were, of the Mind, catch at and grasp mere Abstractions, but rather actually penetrate Nature and discover the properties and Effects of Bodies, and the determinate Laws of their Substance (so that this Science of ours springs from the Nature of Things as well as from that of the Mind); it is not to be wondered at if it have been continually interspersed and illustrated with Natural Observations and Experiments, as Instances of our Method. The *Prerogative Instances* are, as appears from what has preceded, twenty-seven in number, and are termed, *Solitary Instances*, *Migrating Instances*, *Conspicuous Instances*, *Clandestine Instances*, *Constitutive Instances*, *Similar Instances*, *Singular Instances*, *Deviating Instances*, *Bordering Instances*, *Instances of Power*, *Accompanying and Hostile Instances*, *Subjunctive Instances*, *Instances of Alliance*, *Instances of the Cross*, *Instances of Divorce*, *Instances of the Gate*, *Citing Instances*, *Instances of the Road*, *Supplementary Instances*, *Lancing Instances*, *Instances of the Rod*, *Instances of the Course*, *Doses of Nature*, *Wrestling Instances*, *Suggesting Instances*, *generally Useful Instances*, and *Magical Instances*. The advantage by which these *Instances* excel the more ordinary, regards specifically either Theory or Practice, or both. With regard to Theory, they assist either the Senses or the Understanding; the Senses, as in the five *Instances of the Lamp;* the Understanding, either by Expediting the Exclusive Mode of arriving at the Form, as in *Solitary Instances*, or by Confining and more immediately indicating the Affirmative, as in the *Migrating*, *Conspicuous*, *Accompanying*, and *Subjunctive Instances*; or by Elevating the Understanding and Leading it to general and common Natures, and that either immediately, as in the *Clandestine* and *Singular Instances*, and those of *Alliance;* or very nearly so, as in the *Constitutive;* or still less so, as in the *Similar Instances;* or by Correcting the Understanding of its habits, as in the *Deviating Instances;* or by Leading to the Grand Form or Fabric of the Universe, as in the *Bordering Instances;* or by guarding it from false Forms and

Causes, as in those of the *Cross* and of *Divorce.* With regard to Practice, they either Point it out, or Measure, or Elevate it. They Point it out, either by Showing where we must commence in order not to repeat the labours of others, as in the *Instances of Power;* or by inducing us to Aspire to that which may be possible, as in the *Suggesting Instances;* the four *Mathematical Instances* Measure it. The *generally Useful* and the *Magical* Elevate it.

Again, out of these twenty-seven *Instances*, some must be Collected immediately, without waiting for a particular Investigation of Properties. Such are the *Similar*, *Singular*, *Deviating*, and *Bordering Instances*, those of *Power*, and of the *Gate*, and *Suggesting*, *generally Useful*, and *Magical Instances*. For these either Assist and Cure the Understanding and Senses, or Furnish our general Practice. The Remainder are to be collected when we Finish our *Synoptical Tables* for the Work of the Interpreter, upon any particular nature. For *these Instances*, honoured and gifted with such *Prerogatives*, are like the Soul amid the vulgar crowd of Instances, and (as we from the first observed) a few of them are worth a multitude of the others. When, therefore, we are forming our *Tables* they must be searched out with the greatest zeal, and placed in the *Table*. And, since mention must be made of them in what follows, a Treatise upon their nature has necessarily been prefixed. We must next, however, proceed to the Supports and Corrections of *Induction*, and thence to Concretes, the *Latent Process*, and *Latent Conformations*, and the other matters, which we have enumerated in their order in the twenty-first *Aphorism*, in order that, like good and faithful Guardians, we may yield up their fortune to mankind, upon the emancipation and Majority of their Understanding; from which must necessarily follow an improvement of their Estate, and an Increase of their power over Nature. For Man, by the fall, lost at once his State of

Innocence, and his Empire over Creation, both of which can be partially recovered even in this life, the first by Religion and Faith, the second by the Arts and Sciences. For Creation did not become entirely and utterly rebellious by the Curse, but in consequence of the divine Decree, *In the sweat of thy brow shalt thou eat bread*, she is compelled by our labours (not assuredly by our Disputes or magical Ceremonies), at length, to afford mankind in some degree his bread, that is to say, to supply man's daily wants.

THE END

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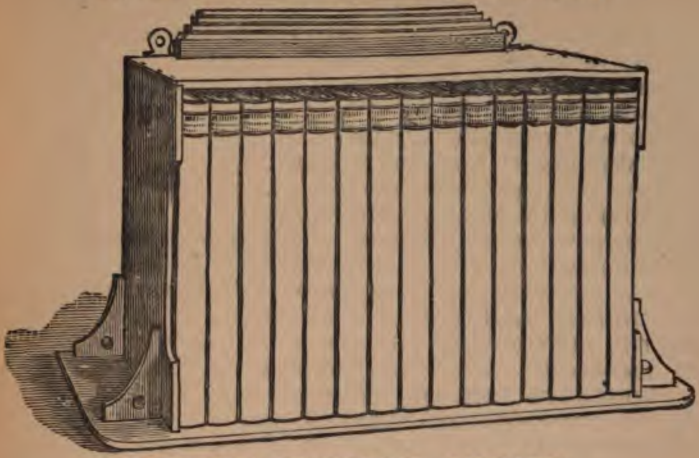

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